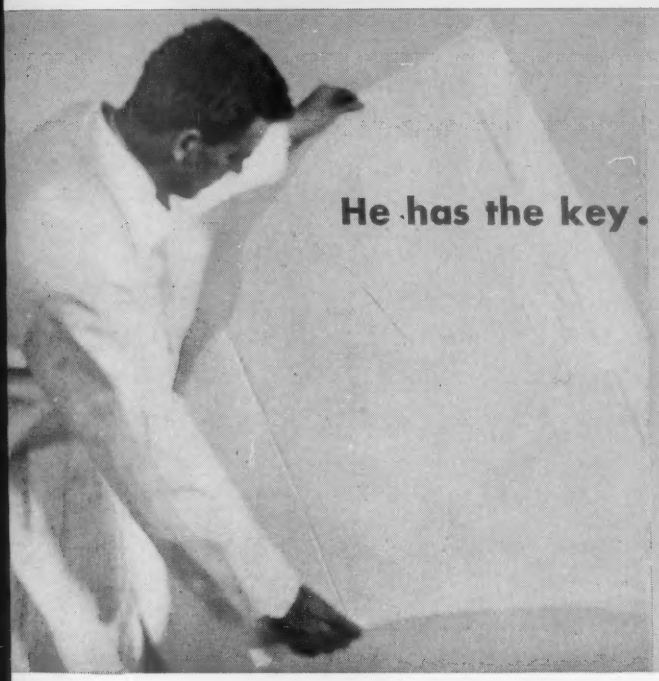
SCIENCE

28 December 1956

Volume 124, Number 3235

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

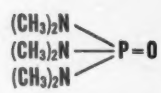
CHEMICALS FOR CREATIVE SYNTHESIS..



He has the key... to manipulating valences, to produce for you—in carload quantities—practically any organic phosphorus compound you need. (HE, of course, is Monsanto's Organic Chemicals Research and Development Department.) From basic research in phosphorus linkages with organic groups—HE can create intermediates that will enable you to build phosphorus into any end product you're researching.

Here are some typical examples of compounds that can be vital links in a new synthesis. Some are useful because of interesting physical properties. Others are valuable "building blocks" because of highly reactive groupings.

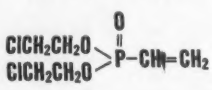
HEXAMETHYLPHOSPHORAMIDE



A high-boiling, clear, colorless mobile liquid crystallizing at 4° C. Spicy odor, low toxicity. Sp. gr. 1.024 at 25/25° C. Extreme range of solubility. Aqueous solutions stable in contact with steel.

AN AMAZING NEW SOLVENT... for extractions, for blending immiscible liquids, for gas scrubbing. Reported to be the most powerful, nonreacting acetylene solvent known. Promising as an intermediate for synthesizing parasiticides and dialkylacylamides (simply heat with an alkanoic acid). Just 0.5—3% stabilizes polystyrene and copolymers against molecular degradation. Patent surveys highlight its use as a solvent for filming or spinning acrylonitrile polymers and copolymers; solvent for cellulose nitrate and vinylidine chloride polymers; for scrubbing out acetylene or HCN from gaseous mixtures.

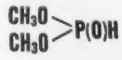
Bis(*beta*-CHLOROETHYL) VINYLPHOSPHONATE



Water-white liquid, mild, pleasant odor. B. p. 132° C. at 1 mm. Sp. gr. 1.318 at 25/25° C. Sl. sol. in water; sol. in most organic solvents.

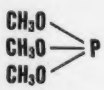
A REMARKABLE NEW MONOMER ... that can be dehydrohalogenated to form mono- or divinyl esters which mass-polymerize to gels. Copolymerizes readily with vinyl acetate and acrylonitrile; self-polymerizes by heat, light, mineral acids, or peroxide catalysts. With basic catalysts, forms addition products with alcohols, mercaptans. Bromine reacts slowly. Reacts with PCl_5 to give $CH_2{=}CHP(O)Cl_2$.

DIMETHYL HYDROGEN PHOSPHITE



Water-white liquid; sharp-sweet odor. B. p. 71° C. at 25 mm. Sp. gr. 25/25° C. 1.200. Sol. in water and common solvents except aliphatics. Hydrolyzes. Sodium salt reacts with alkyl and acyl halides. Forms addition compounds by linking to carbonyl and olefinic double bonds. Reacts with chlorine to form chlorophosphate.

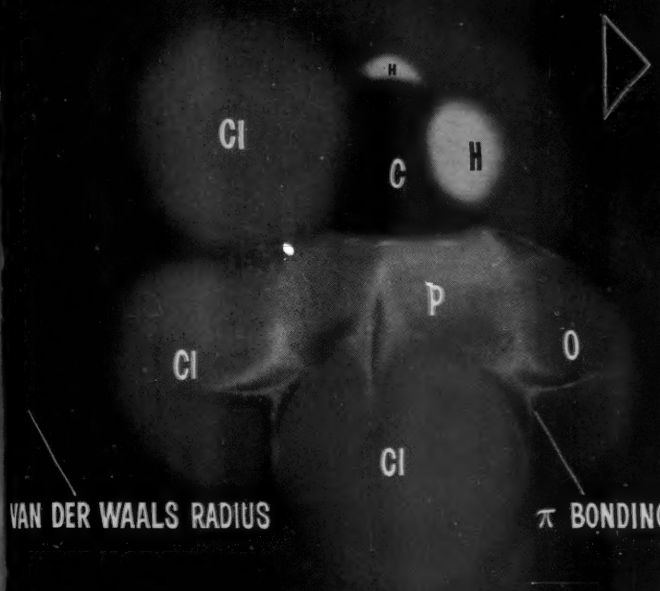
TRIMETHYL PHOSPHITE



Water-white liquid. Pungent odor. Boils at 111° C. Sol. in most organic solvents. Insol. in water—hydrolyzes slowly. Sp. gr. 1.046. Readily hydrolyzed by acids, reacts with alkyl and acyl halides. Can act as alkylating agent. Reacts with SO_2, PCl_3, RCOCl, R_2NCOCl, benzoic acid, $MeSO_3H$.

When you need a new composition of matter containing phosphorus in any organic combination...you are invited to consult Monsanto.

STEPPINGSTONES TO TOMORROW'S PRODUCTS



New concepts lead to new products. This is the latest concept of the molecular structure of (chloromethyl)phosphonic dichloride showing pi-bonds and van der Waals radii. Keeping up with new concepts is part of Monsanto's effort to produce efficiently scores of new

Organophosphorus Compounds

Here are NEW CHEMICALS FOR INDUSTRY ready for commercial evaluation:

(CHLOROMETHYL) PHOSPHONIC DICHLORIDE

$ClCH_2P(=O)Cl_2$

Colorless liquid, irritating odor. Stable to 250° C. Soluble in most organic solvents.

Hydrolyzes readily to phosphonic acid. Phosphorus-bonded chlorines extremely reactive—almost equal to PCl_3; carbon-bonded Cl is less active. Example: the phosphorus-bonded chlorines react with alcohols to give a diester; carbon-bonded chlorine will then undergo alkaline hydrolysis to give a hydroxy phosphonate. Methyl and ethyl diesters readily prepared. Aminates to a secondary amine, $HN(CH_2PO_3NH_4)_2$. Aniline salt and dianilide have been prepared.

Bis(*beta*-CHLOROETHYL) *beta*-CHLOROETHYLPHOSPHONATE

$(ClCH_2CH_2O)_2P(=O)-CH_2CH_2Cl$

Colorless liquid above 37° C. Soluble in acetone, methanol, benzene. Insoluble in hexane, water. B. p. (5 mm.) 170.2° C. Readily supercools.

Resists hydrolysis, but hydrolyzes or chlorinates to half ester more readily than simple phosphonates. With HCl and heat, yields 2-chloroethanephosphonic acid. May be dehydrohalogenated to give *bis*(*beta*-Chloroethyl) Vinylphosphonate, which can be polymerized to viscous resins. Reacts with PCl_5 to give ester chlorides which react with aniline.

Tris(*beta*-CHLOROETHYL) PHOSPHITE

$(ClCH_2CH_2O)_3P$

Pale-yellow liquid. Soluble in acetone, benzene, methanol with some interaction. Insoluble in water, hexane. B. p. 112-115° C. (2.5 mm.).

Undergoes many of the reactions typical of trialkyl phosphites including thermal rearrangement (Arbusov); reacts with alpha-halogenated carbonyl compounds to form vinyl phosphates. Possible uses: lubricating-oil additive, antioxidants, wetting agents, flameproofing agents.

AMMONIUM O, O-DIETHYL PHOSPHORODITHIOATE

$(CH_3CH_2O)_2P(=S)-SNH_4$

White-to-tan crystalline solid. Readily soluble in acetone, EtOH and water. Unstable in aqueous acid solutions.

Hydrolyzes slowly in water. Decomposes near 165° C. Acid is readily prepared by treatment with HCl. Both the acid and salt forms are highly reactive. Possible uses: insecticides, photographic chemicals, oil additives.

You can keep abreast of the rapidly developing field of organophosphorus chemistry through Monsanto—basic in phosphorus production, basic in the know-how of combining phosphorus with organic radicals.

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Monsanto Chemical Company
Organic Chemicals Division
Dept. IN-2S
St. Louis 1, Missouri
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Send to:
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"Reports" in *Science*

During 1956 the editorial board and the editorial staff of *Science* reviewed the functions and the scope of the section entitled "Reports" and attempted to define as clearly as possible the policies that should be followed in accepting papers for publication in this section.

It seems clear that the guiding principle for acceptance of reports is the interest of the readers. In this connection, it should be pointed out that reports, which are short technical papers from several fields of science, have a considerable value, both to small libraries and to individual readers who have little access to the specialized literature of science. *Science* plays a larger part in the dissemination of specialized information than may be commonly supposed. Some indication of this is obtainable from data tabulated by C. H. Brown in his recent study of scientific literature [*Scientific Serials* (Association of College and Reference Libraries, Chicago, 1956)]. His tabulations show that in 1954 *Science* was among the 50 publications cited most often in the bibliographies of a balanced selection of the world's specialized journals in five fields: botany, chemistry, geology, physics, and physiology.

Some readers think that the growth and specialization of science have been great enough to make it inappropriate for any journal to publish specialized articles in several fields; others think that the reports are a valuable section of the magazine. The editorial board agrees with the latter view and thinks that we should continue our efforts toward improvement. One way to improve the section in usefulness to both reader and author would be to speed up the rate of publication. Considerable progress has been made in this respect in the last few months. On 1 May 1956 we had on hand 131 accepted papers; by 6 December 1956 we had reduced this backlog to 11. During the same period, we reduced the time for publication (that is, the time from receipt of the paper to publication or, if revision was required, from the time of receipt of the revised report to publication) from an average of more than 5 months to less than 3 months. In order to reduce the time lag for publication still further, we shall in the future urge our referees to return papers to us within 2 weeks. If this can be generally accomplished, we hope to be able to publish reports in 6 weeks or less, on the average.

The problem of what constitutes an acceptable report for a general journal like *Science* is not easily solved. In general, papers have to be judged on a balance of factors, including general interest, interest to readers in more than one field, and interest to the specialist. Papers that are of outstanding merit in any of these respects are favored for acceptance. But there is another factor to be considered: papers must meet our limits of length (not more than 1200 words or the equivalent, including tables or figures).

We hope that by maintaining a rapid schedule of publication we will attract more papers of the kinds that we should publish and that these papers will come to us from a wide variety of fields. If this hope is realized, the probability that any reader will find one or more papers of interest to him among the "Reports" will be increased, and the section will become an even more useful part of *Science*.—G. DUS.

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The Future through Science

Glenn T. Seaborg

As we consider the future of our country and of the world, we can perceive that our human resources of trained brainpower in all fields, including those of science and engineering, are foreordained to be of crucial importance to our destiny. It is my belief that we only dimly perceive the extent to which this is true, and that by no means are we taking the necessary steps to encourage the adequate development of this brainpower.

We, the people of the United States, are the most fortunate large group of people on the face of our planet in terms of our physical well-being, personal liberty, material comfort, and the opportunities open to us for social and intellectual development. We occupy only 7 percent of the world's total land area and number only 6 percent of the world's population, yet we are privileged to use 40 percent of the world's total electric power, to drive three-quarters of the world's automobiles, and to communicate through 60 percent of the world's telephones. We own 30 percent of the world's radio and television sets. In going about our daily business, we manage to use up two-thirds of the world's supply of newsprint, 60 percent of the world's annual production of aluminum, 40 percent of the world's annual supply of chromium, one-third of the world's annual supply of tin, and 50 percent of the world's annual supply of copper. Our gross national product of goods and services has soared from $56 billion in 1933 to $90 billion in 1939 to $375 billion in 1955.

Although we may think we enjoy this great prosperity simply because we richly deserve it, other more substantial reasons can be uncovered. We live in a land highly favored in climate and natural resources. Our shores have great natural harbors. We have extensive systems of rivers and lakes for internal transportation and irrigation. We possess extensive fertile range and farm lands situated in several climate zones, permitting the production of large yields of greatly varied grains, fruits, and vegetables. We have great forests, large amounts of water power, large deposits of coal, oil, copper, iron, uranium, mercury, zinc, phosphates, sulfur, and a host of other important metals.

We owe much to our democratic political system. We can be thankful to our tradition of religious toleration and the separation of church and state, which allows one man to pursue those goals and engage in those activities that could have been prohibited by the religious convictions of another. During the early decades of our history, the geographical isolation of the United States aided greatly in the evolution of our governmental and social system without serious molestation from without. Our particular system of capitalistic business enterprise, regulated in many important ways by government, provides, by-and-large, in an excellent way for the interests of the stockholder, the manager, the working man, and the consumer. The development of our public school system and the growth of our private and state institutions of higher learning have had an important role in all phases of our history in providing a literate and intelligent electorate, a group of skilled workers, and the core of leadership in the professions, business, religion, and public life.

The author is professor of chemistry and chemical engineering at the University of California, Berkeley. This article is based on an address given 27 Dec., during the annual meeting of the AAAS, in New York, at a banquet held to honor the 25th anniversary of the Gordon Research Conferences of the AAAS and to pay tribute to the memory of Neil E. Gordon.

Debt to Science

To all these and other fundamental reasons for our present prosperity that are widely understood must be added another factor which has achieved its greatest importance only in the past two decades and is not so widely recognized. This factor is the firm establishment of scientific research and development as an important base element of our industrial system. The importance of the scientist and engineer in the development of the weapons of war is well recognized because of their impressive record in World War II, but the contribution of the scientist in times of peace is even more important.

The farmer of 1900 farmed with methods not greatly different from those of previous centuries except for the introduction of the horse-drawn steel plow, the reaper, and a few other simple machine tools. Our farmer of 1900 would not recognize the practice of farming as it is carried on in 1956. Indeed, most city people do not realize the extent of the revolution in farming methods that has occurred in the past 15 years. The introduction of more and more specialized motor-driven tools, of scientifically developed strains of crops and scientifically bred cattle, of new irrigation techniques, of weed-controlling chemicals, of insecticides, of new fertilizers and fertilization techniques, and of chemicals for the control of growth and disease in poultry and cattle has allowed great expansion in productivity in the face of a sharply declining farm population.

In medicine, we have seen the development of the sulfa drugs, the antibiotics such as penicillin, streptomycin, aureomycin, erythromycin, and the sterol derivations such as cortisone; the introduction of new operative techniques, a better understanding of viruses, and polio vaccine; the development of new drugs for the treatment of mental disease; and other developments too numerous or too technical to mention.

Every household is familiar with the miracle fabrics nylon, Dacron, and Orlon. Soap, which remained for cen-

turies mankind's principle cleansing agent, now runs second best to its tersely labeled synthetic successors, Dreft, Treet, Trend, Tide, Surf, All, Add, Fab, Dash, Vel, Joy, and Cheer.

Space allows only a brief recitation of important industrial products and accomplishments: synthetic rubber, plywood, plastics, foamed plastics, television, high-fidelity sound reproduction, synthetic adhesives, paints and corrosion-resistant coatings, new methods of printing and reproduction, color photography, titanium, tantalum and zirconium metal, transistors, magnetic tape, solar batteries, electronic computers, nuclear reactors, jet aircraft, atomic-powered submarines, and so forth.

Each phase of our everyday life, whether it concerns food production, heavy industry, transportation, communication, commerce, entertainment, public health, medicine, home life, or our social behavior, depends very directly on the development of these new products. It is hard to establish in cold dollars and cents what part of our gross national product depends directly or indirectly on the scientific applications that have been developed to commercial usefulness only within the past decade, but it certainly is a substantial percentage. Two of our largest concerns, Dow Chemical Corporation and Monsanto Chemical Corporation, trace 30 to 40 percent of their 1956 sales to products that have been developed in the last 10 years. The new agricultural chemicals alone—the fungicides, herbicides and insecticides—constitute a $400 million-a-year business. Eighty thousand employees of the General Electric Company work on products that did not exist before the end of World War II. A spokesman for the National Science Foundation estimates that United States industry as a whole gains back $20 to $50 for each $1 that has been spent on research during the past 25 years.

Now, while it is true that a rather large proportion of our population is involved in the manufacture, distribution, and sale of these products, it is also true that the original conception and development of the ideas upon which these products are based were carried out by a comparatively miniscule fraction of the total population. In this age of specialization we all find it possible to enjoy the benefits that stem from the ideas of the few without understanding what those ideas are. We find it sufficient for our purposes that some among us are able to synthesize penicillin, design an atomic reactor, solve a system of simultaneous equations on an electronic computer, trace the course of photosynthesis, or take a photomicrograph of a living virus. To enjoy the advantages of our complex industrial society, we recognize the necessity for this interdependence and give up the greater self-reliance we possessed in an earlier age. We give thanks that the specialists somehow seem to appear to solve the problems we cannot solve ourselves.

In our situation, when so many of us owe so much to the few, we would suppose that one of our chief national concerns would be for the conservation of our most important natural resource—trained brainpower. However, there are many signs that this is not the case. Let us consider some of the tasks of the future for which we shall require all the assistance we can get from trained brainpower—from the scientist, the engineer, the lawyer, the industrial executive, the economist, the social scientist, the statesman, and many others.

First of all, merely to maintain our present economy we shall have to carry out scientific research and industrial development on an accelerated pace. Basic science will have to be given strong support, and the intellectual geniuses among us must be discovered, trained, encouraged, and rewarded. A large body of trained workers and technicians must be raised to fill many new types of industrial positions.

Second, we must face squarely the implications of an expanding population. The present population of the United States in 168 million, increasing at the rate of 1.5 percent annually. This means a 35-percent increase in 20 years and an increase of almost 100 percent by the year 2000—only 43 years hence. Our power consumption will go up at a much greater rate. The total installed capacity for power generation in this country is roughly 100 million kilowatts. The Federal Power Commission estimates that we shall need three times as much by 1980. We are rich in coal, oil, and water power, but not nearly so rich that we could meet this staggering increase with these sources of power alone. Hence we may expect to see a great development in nuclear power generating capacity. In a few decades, atomic power will be for us an absolute necessity. In several other major industrial countries, such as England and Japan, which are even now running out of reserves of fossil fuels, atomic power is a necessity within the coming 20 years. There is also hope that solar power or the use of controlled thermonuclear reactions will add eventually to our supply of energy from other sources.

Our population growth of the next 50 years poses other problems of no mean magnitude. Our present farm surpluses will disappear, and we shall require all the skill of our soil scientists, agronomists, and agricultural experts to raise productivity to the required levels. New methods of processing food to secure greater utilization of our plant and animal crops and to reduce waste and spoilage will have to be devised. We shall be faced with increasing difficulties in obtaining sufficient forest and mineral products. The adoption of adequate conservation policies and the development of substitute materials will assume great importance. Our normal sources of fresh water will have to be supplemented on a large scale by fresh water obtained from the sea. Congestion in our cities will intensify our present problems and create new ones in transportation, utilities, water supply, waste disposal, public health and recreation, and mental health and social behavior. We may be forced to reduce drastically the waste of resources entailed in the unlimited production of consumer goods that is symbolized best by the American automobile. The automobile is a peculiarly fertile species that reproduces freely and appears to have no natural enemies sufficiently powerful to hold its growth in check. Furthermore, its reproduction has the peculiar feature that the offspring is always 6 inches longer, 3 inches wider, 10 percent more powerful, and 20 percent shinier than its parent. It will be interesting indeed to note the breeding habits of the automobile 50 years hence.

School Crisis

These are but a few of the internal problems that we must face and that will have to be solved largely by the young men and women whom we are training in our schools today for intellectual leadership. If my analysis means anything at all, we need to insure that a high percentage of our most gifted young people be trained to a very high degree in intellectual and professional fields. The graduates of the near future must exceed those of the past generation not only in numbers but in quality. Unfortunately, the alarming crisis in our school system makes it certain that we shall fall far short of this goal. Without strong emergency measures, the results may be extremely serious.

We have a school crisis because we have an almost explosive increase in the numbers of students at the same time that the social and economic position of the teacher relative to the rest of society has fallen so precipitously that only a small fraction of the needed qualified teachers can be found. The birth rate was abnormally low during the depression of the 1930's, but it has risen steadily since. In 1956 the number of children born was more than 4 million, or twice that of 1935. The tidal wave of new students has reached the primary schools and is reaching the high schools, resulting in the overcrowding and split sessions so common in most communities. Six

million children were in secondary schools in 1946, 8 million are there today, and in 1966 there will be 12 million with the peak still not reached.

Our colleges are just now feeling the upswing after the downturn following the expiration of the GI Bill. Not only is the college-age population growing, but the percentage of that population seeking a college education is also increasing. Our present college enrollment of about 3 million will increase to at least 4.5 million by 1966 and could well climb to 5.5 million. Certain areas such as my home state of California will be particularly affected. In California the population will increase 30 percent in the next 10 years. The school population at all levels will increase by as much or more. If we were prepared to maintain educational standards for such an expanded school population, these statistics would be very heartening, for universal education has always been one of our cherished dreams. Considering the great deficiencies in our preparation to meet these phenomenal increases, our dream will have some nightmarish aspects.

The physical space simply does not exist to accommodate these students. We need something like 700,000 new classrooms for the next few years, not to mention laboratories, libraries, and recreational and other facilities. Finding the teachers to staff these classrooms is an even more difficult problem. We shall need 600,000 new teachers by the end of this decade. At the college level we shall need 25,000 new faculty members per year. To supply these totals over the next few years would require that one half of the recipients of college degrees accept jobs as teachers. At the present time, only 20 percent do so, and the percentage is likely to decrease rather than increase, particularly among graduates with training in the sciences. Hence the quality of teaching, particularly at the high-school and grade-school levels, is certain to decrease. Even if teachers were well rewarded, we could not hire enough highly qualified teachers because the potential supply is so much less than the total demands of industry, government, and education.

But teaching, far from being a well-paying profession, is one of the most poorly rewarded occupations. The starting salaries are substantially less than those available in industry for college graduates and after many years of service will not increase substantially, whereas a college graduate in industry will typically double his salary in 5 years. Electricians, plumbers, auto workers, and railroad conductors and engineers earn more than teachers. Considering the depreciation of the dollar, the real income of the teachers has actually fallen since 1940. Every year thousands of capable, effective teachers who love the work they are doing leave the profession because they simply cannot support their families in any decent standard of living on the pay that they receive. It is pure fantasy to believe we can bring about any real change in our school systems without a drastic change for the better in the economic incentives for teachers.

These factors have led to a severe decline in the quality of our secondary-school education. Half the American public high schools offer no foreign language at all, and one-quarter teach no physics or chemistry or geometry. Students get less and less contact with basic fields of science. In too many schools the inspiration of a gifted, inspiring science teacher has disappeared completely. Students of unusual intellectual endowment are not encouraged or are actually repelled, and if later they do develop an interest in science they find that their high-school preparation is inadequate to permit them to elect a science or professional major field of study in college.

These school problems are of such proportions that they cannot and will not be solved for many many years, but determined steps can be taken to check a complete breakdown in the quality of the education of our youth while we rebuild for the future. Limited space does not permit me to review the many recent actions of local communities, of private foundations and corporations, of scientific societies and other social and political groups which indicate an awareness of this problem and the initiation of steps to alleviate the evils. I should like to add a few personal comments on possible solutions.

First, a great many more of us are going to have to realize how important it is to our continued national well-being and progress to maintain and expand our public school system. Our forebears had no sooner set foot on the soil of New England or entered the forests of Pennsylvania or Kentucky than they entered upon the construction of schools and procured a schoolmaster so that their sons should achieve the elementary literary skills so necessary and prized even in a pioneer community. Our own sacrifices to this ideal are small by comparison, and surely there is room for additional support on our part in the form of taxes and effort. Surely a nation that can efford $5 billion annually for tobacco, $1.7 billion for newspapers and magazines, $10 billion for hard liquor, $2 billion for television sets, $1.3 billion for movie tickets, and $1.2 billion for foreign travel will not be brought to its knees by some billions of additional expenditures for education.

We must immediately put out sizable funds for classroom construction and for drastic increases in the pay scales of our teachers. I do not see how we can avoid the conclusion that a large part of the money for this purpose must come from the Federal Government. I see no fundamental reason why methods for the dispersal of such funds cannot be worked out without endangering local control of our schools. We need to establish the principle that it is in the national interest that every student above a certain level of ability, regardless of his origin and the status of his family's finances, is privileged to carry his education as far as his personal motivation and his scholastic ability will carry him. This principle requires that a system of scholarships paying a major fraction of tuition, book, and living expenses be established. These scholarships should give the student wide limits in his choice of school and choice of field of study.

We need to explore new teaching techniques. We are not quite sure of the most effective role of television, audiovisual aids, and other methods in and outside of our modern classrooms, but certainly their role is important and should be explored thoroughly at once so that our limited numbers of teachers can be used more effectively. We need to relieve our present teachers of the clerical and menial tasks that take up one to two-thirds of their time. For the gifted student, we should explore techniques of self-teaching and individual study with much less detailed guidance from the teacher. We must reexamine our licensing procedures, which now contain much nonsense. We need to do a much better job of counseling the young and instilling a better attitude or motivation toward intellectual pursuits in general. In this regard, it is not enough to emphasize the importance of advanced intellectual training; we must also present a clearer picture of what a scientist actually does and try to convey some appreciation of the fun, the thrill, and the inner satisfaction which a scientist usually experiences in his career. Professional men within each community can assist greatly in this problem of counseling, and indeed I am fully aware that many member organizations of the AAAS have active programs in this area.

Many reforms are also necessary in the university science departments to maintain the high position of university research as a fountainhead of new ideas. I believe we need to establish more research professorships so that outstanding research scientists who may not be needed or suited for formal teaching are able to assist in the training of graduate students. We need to set up new central campus facilities for electronics development and service, radioactivity measurements, computing equipment, and so forth, so that the research man can spend

his time on new experimental ideas rather than on the menial tasks of equipment building better done by technicians. My space does not permit me to expand here on the many ways in which we can foster the work of the creative thinker on the campus.

World Situation

I have indicated that the serious educational problems we presently face are of considerable concern because of our internal situation arising from an expanding population. Our concern is greater when we consider also the problems of foreign policy. The problems raised by rising population in our country are minor compared with those in many nonindustrial areas of the world. We are in an era of rising nationalism, an era of what Chester Bowles has called rising expectations, among the backward and colonial peoples of the world. The transition of these peoples to stable democratic self-government and to the status of modern industrial states which most of them aspire to become would be a herculean task, even if it were approached in a completely rational manner by all parties concerned. We know only too well that confused, emotional, and irrational steps leading frequently to bitter and ugly armed strife have too frequently marred the attempted transition to a better way of life.

These problems would certainly have been with us even without an ideological conflict with the Soviet Union. This conflict of course adds greatly to the problem of the emergence of the former colonial and backward nations. It also adds greatly to our own insecurity. For the first time in our history we are faced with the certainty of extensive damage to our own cities and civilian population in the event of a major war. In quantitative terms, this change is almost the most extreme that could be imagined. During and at the end of World War II no nation had the power to inflict serious physical destruction on continental United States. Today or in the near future, the Soviet Union has, or will have, the bombers and the atomic and thermonuclear bombs to lay waste the centers of all of our major cities, within a very short period of time, and to annihilate a sizable fraction of our population. We have defenses against such an attack, but our defense is only partial. Within a few years—perhaps 5, perhaps 20—both the United States and the Soviet Union will have perfected the intercontinental ballistic missile with a thermonuclear-bomb warhead. Against this ultimate weapon an effective defense is extremely unlikely.

Our main program at the present time is the grim and uncomforting reliance on the mutual deterrent power of annihilation, the threat of counter blows so completely damaging that no rational government would initiate a large-scale war. In lieu of any real agreement with Russia and with other nations on arms limitation and inspection, this is our chief national policy. Plausible arguments can be given for believing that peace can be maintained on this basis of more and bigger bombs and surer means for their delivery. I regard this policy as somewhat disturbing, and as several more nations are added to the present three in possession of nuclear weapons, I shall regard the policy with even greater uneasiness. Countries such as France, Sweden, Belgium, Germany, and Japan clearly have it within their scientific and industrial resources to develop atomic bombs within a few years.

I am not at all sure that nuclear disarmament with adequate safeguards against treachery can be achieved, but it is vital that we maintain a continuing evaluation of every possible approach. I see no fundamental reason why we of the West and our ideological opponents behind the iron curtain cannot ultimately adjust our differences sufficiently to live side by side in mutual trust. The appalling waste of the nuclear arms race and its threat of potential utter disaster are two of the central problems that face us in the next few decades.

The Future

This problem and the others I have all too briefly sketched will not be solved by scientists alone or by an educated elite alone. But no solution will be successful which ignores the scientific and intellectual basis of modern civilization. We need highly skilled specialists to attack the agricultural, industrial, social, and governmental problems not only of our own country but of every part of the globe. We need many new specialists in fields to which we have paid scant attention on a national scale in the past. We need to understand the language and customs, the history, the hopes and fears of other nations so that our technical skill can be effectively applied to the problems of development in other lands. The solution of these problems is vital to our own security and to the emergence of a more satisfactory world order.

We need great leadership in all fields by men who are cognizant of the values of our civilization and the factors which influence it. The liberal education that prepares men for such leadership must include science as an integral part, for science is too central a part of our modern culture to be ignored.

We may look forward to many wonders in the coming 50 years. Large earth satellites will continuously circle the earth and monitor the weather, making weather prediction a much more certain matter. We may even effect large-scale control of the weather itself in some areas. Manned satellites may be possible, and space travel to the moon may be achieved. Large ships will be propelled almost exclusively by nuclear power plants. Air travel to any part of the world will be a matter of a few hours. We shall have TV phone communication. Our knowledge of photosynthesis and the processes of the living cell and bodily functions will be enormously more complete, giving us greater control of disease. We shall exercise greater control over human fertility. Problems of mental health, delinquency, and crime should yield to better understanding of biology and of mental processes and social behavior.

We cannot take it for granted that these things will come to pass, that our country will continue to prosper, that the continuing international crises can be overcome without disaster. We must recognize the hazards and prepare ourselves to meet them. The last 25 years have emphasized to any discerning person the importance of trained brainpower to our future—to our scientific future in which our economic prosperity and military security are by no means assured. It would be perilous indeed to neglect the discovery, training, and encouragement of the intellectual leaders of this generation and of the generations of the future.

Gordon Research Conferences

A Quarter-Century on the Frontiers of Science

W. George Parks

We have to be practical; we have to concern ourselves with learning to apply what knowledge we now have. This was a philosophy that pervaded the early 1930's, and understandably so. It was a period of dismal depression. Basic research was regarded by many as bordering on the impractical, and there was little latitude, financial or mental, for anything but earnest practicality.

It was a time when many scientists were forced to focus their thinking on the then pressing present; it was a time when few were inclined to cast their thoughts toward the future. But fortunately one man, at least, was an exception. Neil E. Gordon, professor of chemical education at Johns Hopkins University, looked far, far ahead. He envisioned what the future structure of the scientific community would be like; he foresaw the communications problems that would arise—problems of such dimensions that they might stultify creativity. And he, with both determination and zeal, set out to do something to nourish the ideas and ideals he cherished. Out of his foresight, out of his enterprise and his dedication to science, a great institution has grown, one that now bears his name—the Gordon Research Conferences.

Gordon was an exceptional man. He founded an exceptional scientific organization, one which, in the words of one of America's senior scientists, "has filled a unique, vital function in the development of science and industry, the true importance of which can never perhaps be fully evaluated."

This year, as the Gordon Research Conferences round out their 25th year of probing the frontiers of science, no simple yardstick can be constructed to measure just what specific contributions they have made to the furtherance of scientific thought and of human understanding. However, there are some measurements of their present stature which are discernible—the annual scope of their discussions, for instance (36 topics); the international reputations of many of the conferees; and the number of scientists (4000) who attend from many countries (46).

Such figures depict an impressive change from the pioneering seminars that Gordon started in modest fashion. But what is more significant is that neither the inherent nature nor the purpose of the conferences has changed over the years. The emphasis is still, just as it was during Gordon's initial meetings, on small, informal gatherings of knowledgeable men—men who relish the opportunity to indulge in unhurried discussion and to explore the thinking and theories of their scientific peers.

This concept, elementary as it may seem against the frame of reference that years of experience have built up, is the foundation on which the conferences have been built; and fruitful as it has proved to be, it is still the conferences' dominant characteristic and towering strength.

No book study this, but the true essence of creative thinking; it is akin, perhaps, to what the unnamed Chinese philosopher had in mind when he formulated the proverb, "A single conversation with a wise man is better than 10 years' study of books," for the conferences embrace not a single conversation but thousands of them between wise men who talk together about what they know best. From such conversations comes an extraordinary mental stimulus that imparts new energy and new impetus to research and scientific progress.

Pioneering Efforts

The late Neil Elbridge Gordon was a man of remarkable vigor, of vast enthusiasm, and of rugged determination. As long ago as 1931, he perceived what to him was unthinkable: the progress of his beloved science was being hampered by its own growth. Or so he believed. Meetings were becoming larger and larger, much to the satisfaction of those who regarded high attendance and growing membership rosters as symbols of vitality. Neil Gordon did not share their enthusiasm. He deplored large meetings, because he felt that they often prevented, rather than promoted, fruitful contacts between creative minds.

Large meetings, haste, confusion, and conflicting interests among attending scientists, all, in his opinion, were impeding progress. Moreover, some meetings, by their very size, were attracting the attendance of people who lacked the deep insight and true interests of scientists. These "outsiders," as Gordon categorized them, not only failed to participate in, and contribute to, worthwhile discussions, but by their very presence interfered with those who would or who could.

Partly as a result of his own observations and experiences, but far more because of his own inner vision, Gordon conceived the original plan of holding small, informal conferences among leaders in research—symposia to explore new areas of thought and experiment, or, as Gordon liked to phrase it, "to push back the frontiers of science."

There were difficulties to be overcome if any such venture was to succeed. Gordon knew this. But he was a man of determination, of determination and faith which are perhaps best typified by his own words: "It is not a question whether we can do this or that or not. It is only a question of whether we are for chemistry or against it. If we are for it, nothing can stop us. . . ."

With such convictions to buttress him, Gordon arranged his first meeting under the auspices of Johns Hopkins University. The participants, who gathered in Remsen Hall (the chemistry building of that university) were students and faculty members. In 1932 there was another single conference ("X-rays and crystal structure"). Ralph Wyckoff led the discussion, and Emil Ott, then a faculty member, was chairman.

A beginning had been made, but just a beginning. However, Gordon and his colleagues had formulated a theory. They were persuaded that the conferences would flourish best if they could be held in relatively isolated surroundings where day-to-day distractions were minimal. With this in view, Gordon arranged by 1935 for a 3-week session at Gibson Island, a small (1000 acres), wooded, hilly island in Chesapeake Bay. Gibson Island provided a unique setting for the scientific symposia. It was sufficiently difficult to reach, and sufficiently isolated, so that most people, once they had managed to get there, decided to stay for the entire conference week. The Gibson Island Club, a private organization, provided meals and sleeping ac-

Dr. Parks is professor and head of the department of chemistry at the University of Rhode Island and director of the Gordon Research Conferences.

Fig. 1. Neil Gordon.

commodations. All in all, the pleasant club, lush vegetation, beautiful bay, golf, and swimming, all combined to make the Gibson Island conferences memorable.

This conference is recorded as the "Fifth annual summer session of the department of chemistry at Gibson Island, Maryland," and the general purpose was described in *Science*:

"The Chemistry Department of Johns Hopkins University is holding its fifth Research Conference this Summer at Gibson Island near Baltimore. The conference is under the general direction of E. Emmet Reid and will run three weeks from June 24th to July 12th. The plan is flexible, varying from day to day according to the nature of the topic under discussion and the wishes of those participating.

"The day begins with a more or less formal lecture outlining some field of research and directing attention to unsolved problems. This presentation is followed by a discussion in which each one present takes a part, making whatever contribution he can to the solution of the problems presented. The ideal is to have a group large enough that all points of view may be represented, yet small enough that all who wish may take an active part.

"The plan is to have recognized leaders in each field of research give lectures and start the discussions, but its success depends on having a number in the group who are capable of contributing ideas.

"The remainder of the day is available for sports or conversations. These conferences are intended to combine mental stimulation, pleasant personal contacts and healthful recreation."

Then it was that the basic concept, character, and structure of the conferences were laid down. And these are the principles that govern the direction of the conferences to this day.

In 1936 invitations were issued for the sixth annual summer session in biology, chemistry, and physics. Then, after Gordon resigned from the faculty of Johns Hopkins, the university organized the seventh annual research conference, which it held at the Cavalier Hotel, Virginia Beach, Virginia. Subsequently, a meeting was also held at the Hotel Henlopen, Rehoboth Beach, Delaware.

In 1937, when Gordon was elected secretary of the section on chemistry of the AAAS, he visualized the continuation of the conferences—as he had originally planned them—under the new auspices of the AAAS. The executive committee of the AAAS voted to authorize the conferences, provided that the association incurred no financial liabilities.

Gordon accepted these conditions without hesitancy. In 1938 a special research conference on chemistry was held under the auspices of the section on chemistry of the AAAS, with Harold Urey as chairman. The site was Gibson Island, and the three topics were "Resinous polymers," "Vitamins," and "Relation of structure to physiological action."

By the end of that year the pattern of the conferences had been cast. Each conference ran for 5 days, Monday morning through Friday afternoon. Morning sessions began about 10 o'clock and continued for 2 hours; afternoons were largely devoted to discussions between individuals or to recreation. The evening sessions began shortly after dinner and often carried on far into the night.

The focus was not on the past but on the future. The discussions were not centered merely on well-established results or known circumstances; rather they revolved about current problems, recent progress, and conjectures and hopes for the future.

Of equal importance was the composition of the group of participating scientists. All were names to reckon with—Urey, Baekeland, Fermi, Noyes, Langmuir, Rossini—and they came from universities and industrial laboratories. Those from academic institutions mingled and argued with those from industry or government, and to the advantage of all. Even scientists who were from competing industrial laboratories subordinated their rivalries in their enthusiasm for the scientific quest.

Over the ensuing half-dozen years, the conferences—the Gibson Island Conferences, as they came to be known—moved ahead slowly but quite steadily. Then stormy weather blew up. Despite the many advantages that the island offered, there were also disadvantages. Harmony did not always prevail between the members of the Gibson Island Club and the visiting scientists; accommodations were limited; the heat and humidity were often uncomfortably high.

In 1946, Gordon and his assistant Sumner Twiss (who had directed the conferences during Gordon's illness) resigned. The conferences were at low ebb; few thought the young, struggling organization would manage to churn through the heavy weather. Those were uncertain and crucial days.

A committee of the conferences, under the leadership of George Calingaert, set out to select both a new site and a new director. The committee appointed W. George Parks of the University of Rhode Island as director and selected Colby Junior College, New London, New Hampshire, as the new meeting place.

The conferences had come very, very close to foundering. Now, in 1947, a new era was opening. (The conferences were officially named the Gordon Research Conferences of the AAAS in 1948.) When the conferences left Gibson Island, they had consisted of ten weekly sessions; soon they had been expanded to 12 sessions at Colby. The conference administrators then pondered an important question: Was it wise to conduct conferences on different subjects concurrently at the one site? An analysis of participants' views revealed that most relished the singleness of purpose of the conferences. Most savored the assurance that anyone they met on the Colby campus was a scientist with kindred experience and objectives. They looked with disfavor on any "intrusions."

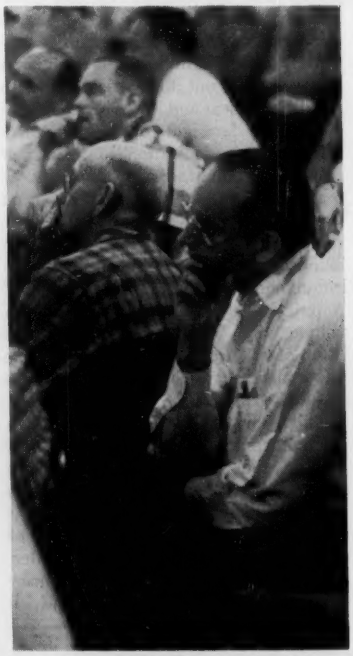

Fig. 2. Participants. [Courtesy George Woodruff and *Business Week*.]

Consequently, in deference to those wishes, an additional site—New Hampton School at New Hampton, New Hampshire—was opened up in 1950. By 1953 it too was accommodating 12 full-week sessions, so a third conference location, Kimball Union Academy at Meriden, New Hampshire, was established. Each of the three sites is now operating at maximum (12-week) capacity. Although there has been pressure to expand still further, it is the present feeling of the board of trustees that no immediate expansion is required. The consensus of the administrators is that 36 topics, well selected and with some scheduled for alternate years, provide a spectrum of subject matter which is adequate to cover the most active areas of science. The conferences are primarily concerned with those active areas where information is developing so rapidly that it is well-nigh impossible for the literature to keep pace.

Fig. 3. Discussion. [Courtesy George Woodruff and *Business Week*.]

Spectrum of Subjects

Gordon was interested in many sciences, but he was devoted to chemistry. Consequently, and as this outline indicates, his original plan was to foster communications among those who were leaders in chemical research. So, by and large, the early conferences dealt with subject matter that was characteristically chemical in nature. But Gordon also foresaw that as science burgeoned there would be more and more specialists who should communicate with other specialists in different but related fields, but who would have difficulty in doing so. Chemists, physicists, biologists, mathematicians, and many others, should share knowledge and experiences, for theirs is a common goal, the search for truth; and a mingling of ideas and concepts through the reaction of active minds is, through what we might term a synergism, enormously productive.

The conferences are still, in the main, essentially chemical. But in large measure they are now more appropriately termed "scientific" meetings with a chemical core rather than "chemical" in a narrow sense.

Last summer's range of topics profiles the breadth of interest which chemistry (and the conferences) now embraces:

Colby Junior College: catalysis, petroleum, separation and purification, polymers, textiles, corrosion, instrumentation, elastomers, food and nutrition, vitamins and metabolism, medicinal chemistry, and cancer.

New Hampton School: organic reactions and processes, metals at high temperatures, proteins and nucleic acids, coal, radiation chemistry, organic coatings, chemistry and physics of metals, chemistry of steroids, analytic chemistry, inorganic chemistry, statistics in chemistry and chemical engineering, and adhesion.

Kimball Union Academy: lipide metabolism, stream sanitation, nuclear chemistry, chemistry and physics of isotopes, solid-state studies in ceramics, chemistry of bones and teeth, chemistry at interfaces, ion exchange, high-pressure research, toxicology and safety evaluations, infrared spectroscopy, and glass.

The number of subjects and the number of scientists who participate in the conferences is now vastly greater than it was even a decade ago. Even though this means that the conferences, as an institution, are large, each conference is itself small. Following the precepts that Gordon laid down, each group is restricted in size (100 to 125 conferees maximum). Discussions are thereby active, and views may be more effectively shared. Formal papers are discouraged; discussion, in the manner of a true symposium, prevails. In order to keep inhibitions at a minimum and discussions as free as possible, no record is kept of what is said, nor is the publication of any aspect of the proceedings permitted.

Many unselfish men have done much over the years to raise the conferences to the stature they now enjoy. Moreover, without the early assistance of a number of cooperative corporations, the conferences would not have been able to shoulder the initial burdens.

But to Gordon alone the conferences are indebted for the vision, the zeal, and the friendly enthusiasm that nourished them through many trying years. Any institution is but the lengthened shadow of a man. Gordon's is a long shadow and one of great substance. Its influence has been felt over the past two decades and will be felt over many decades yet to come.

New Approach to the Problem of Man's Origin

Helmut de Terra

That the process of human evolution must be seen in a geologic perspective, and also that it involves fossil evidence of Old World primates of the Tertiary epoch, has long been realized. Precisely in what manner, and in what geologic period, the emergence of truly hominid forms occurred—whether from ancestral anthropoid apes or from a less specialized form—has to this day remained an unsolved puzzle. A few students of this problem have hypothesized an early, nonanthropoid origin of the evolutionary line leading to man (*1*), although the anthropoid theory of human origin is generally favored over any other interpretation.

It therefore came as a surprise to most anthropologists and paleontologists when a Swiss paleontologist, J. Hürzeler of the Natural History Museum at Basel, stated that *Oreopithecus bambolii* Gervais from the younger Tertiary of Italy was an ancestral hominid. No manlike creature had hitherto been recorded from a geologic period as remote as the beginning of the Pliocene millions of years ago. Although that fossil had in 1872 been assigned to the Old World monkeys, certain scholars, such as Forsyth Major and G. Schwalbe, had long ago called attention to anatomical characteristics suggestive of a phylogenetic position different from the one originally assumed by Gervais.

A comparative study of European primate fossils by Hürzeler led him to reexamine an impressive number of skull fragments of *Oreopithecus,* mostly loaned from Italian collections. Among them were several mandibles, and the proximal parts of a femur and ulna. Hürzeler's first description of the dentition (*2*) was followed by a shorter publication in 1954 (*3*) that called attention to a unique combination of features more manlike than simian: closed dental rows; bicuspid shape of the anterior premolars; vertical position of the incisors; relatively small canines; humanlike proportionate length of teeth; rounded but nearly vertical mandibular symphysis; mental foramen at or above the medium height of the mandibular corpus; the ascending ramus generally concealing the last molar completely; zygomatic arch beginning either above the first molar or even above the posterior premolar, indicating a short face; and hominid shape of the ulnar fragment.

While Hürzeler's findings indicate a reassessment of man's pedigree, they also renew our interest in the European field as rivaling other regions, such as Africa and India, with respect to fossil evidence of this kind. The last aspect will not surprise those who are acquainted with the geologic conditions that created environments favorable to higher-primate life in the Miocene and Pliocene periods of Europe. Such fossil remains are known from regions ranging from the eastern Alps and the Vienna basin clear across Europe to France and Spain. Hence the merit of Hürzeler's studies lies partly in his calling attention to the prospects on European soil for a concerted attack on one of the most challenging puzzles of natural science: the descent of man. With such prospects in mind, I volunteered last spring to aid Hürzeler's studies in the coal-mining district of Grosseto Province in Italy, where he and others before him had obtained stray fragments of *Oreopithecus.*

Thanks to the financial aid of the Wenner-Gren Foundation for Anthropological Research, it was possible for Hürzeler to lecture last March in New York and at Harvard University and present his fossil material. It then appeared that the problem, as stated by him, called for additional specimens and geologic field studies that might permit better judging of the merits of his claim with regard to the hominid affinities of *Oreopithecus* and its geologic age. Such an investigation was initiated last spring and summer with grants from the same foundation under its auspices, and with the cooperation of the Natural History Museum at Basel, the University of Pisa, and the Institute of Human Paleontology in Rome.

Notwithstanding the great interest evinced by the Italian institutions, it was not possible on short notice to assemble a team that could work on a schedule that would allow the participating members to spend all their time together in the field (*4*). Owing to previous arrangements, the actual geologic mapping was entrusted to L. Trevisan of the University of Pisa, whose colleague E. Tongiorgi is expected to continue with his paleobotanical contributions to the problem.

Finding a Site

Considering that fossil specimens had previously been found only in coal-mining operations underground, most of which had long ago been abandoned, it seemed important to locate a surface outcrop of the fossiliferous coal suitable for excavations. Such a prospect appeared at the mine of Ribolla near Grosseto at a place called San Feriolo. Here the coal appears in faulted position on the surface, and it was found to contain numerous fossil tree trunks, suggesting a swampy forest in marginal position to the coal basin. This spot seemed all the more promising because of indications of two separate bone beds recorded in an ancient drilling log some 800 feet from the surface outcrop. Unhappily, these expectations for finding the *Oreopithecus* horizon at this place did not materialize. Surface trenching in various directions yielded no fossil bones, possibly because of the deep alteration that the coal has suffered from fracturing and weathering.

I then inspected other localities in the vicinity of Ribolla, surveying parts of the basin and finding some extensive coal outcrops at Casteani and Aquanera, where local informants vouched for previous finds of fossil bones, including *Oreopithecus* mandibles, which had been turned over to museums in Italy. At these places surface searching was of no avail, the ancient coal dumps having disintegrated and partly burned.

No sooner had these hopes been abandoned when news came that the coal mine of Baccinello was to be reopened at the end of May. As it turned out, this event came to offer the finest chances that Hürzeler and I had anticipated on the basis of previous finds, among which was a complete skull and other skeletal parts, some of which had been salvaged in 1951 or 1952. The earlier finds at Baccinello had given rise to the claim that a complete skeleton had been found, which may well have been the case, but

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proper supervision was not then available.

While the first attempts at excavation at Ribolla disclosed weathering and structural factors inimical to preservation of fossil bones, future studies of similar coal outcrops may well result in more positive finds. No less than 17 occurrences of lignite coal are known from Tuscany, scattered over some 1000 square miles and associated with intermontane basins containing fresh-water formations of the younger Tertiary. Until this extensive area has been thoroughly searched, the mine at Baccinello and its vicinity will remain the most promising locality for an exhaustive study of the *Oreopithecus* problem.

Excavations

Mining operations at Baccinello started at the beginning of June, and with them appeared right away the first fossil fragments of *Oreopithecus*. An inspection of the coal some 400 feet underground by Hürzeler and me revealed no proper bone bed. The first fragments, a lower mandible and pieces of ribs and vertebrae, were picked up in the colliery from the first diggings. The underground chamber was reached by what to us seemed a hazardous descent by cable car and ladders. A special reflector lamp borrowed for this first inspection illumined the coal all right but revealed only one bone fragment. In the following weeks and months, new specimens appeared intermittently over a distance of some 250 feet and at the same level. Hürzeler estimated that they belonged to no less than five individuals. Such local concentration of fossil primate remains would seem to be unique among all the sites known so far from the younger Tertiary.

Beginning with the first finds, I initiated a control of the mined coal whereby pieces with bone fragments were hand picked in the colliery before the coal was fed into the crusher. Obviously this method would never do in salvaging the larger parts of the skeleton so we considered our chances for excavations underground. It was discouraging, to say the least, to watch precious specimens being hacked to pieces when we needed a complete skull, pelvis, and limb bones.

Under ordinary circumstances, it might have been expedient to apply to the government to protect the site by enforcing a temporary stoppage of mining operations. Such interference would have given us a chance to exploit our prospects. Unhappily, the circumstances would never permit such drastic action. The mine had been reopened through the initiative of a miners' cooperative, and it provided a livelihood for 120 men and their families, most of whom had lived through years of near-starvation from unemployment. In this desperate struggle for ultimate acquisition of the mine, no heed could be paid to scientific aims. The only chance to excavate for fossils underground was to supplement the labor force at our cost and, after some exploratory diggings, to start mining coal at a place reserved for this purpose. Considering the dilapidated condition of the mine, this would have required special equipment and technical supervision at a prohibitive cost.

Geology

Meanwhile, invitations had been sent by G. Caputo for a conference to be held at Grosseto that would permit our Italian colleagues to discuss their chances for cooperation. How great their interest was is evident from the number of participants who represented ten institutions. They were given a chance to visit the mine and to inspect the first finds. Existing arrangements having found their approval, I then started to look over the terrain for stratigraphic clues and geologic prospects for surface excavations. The question of the geologic age of the *Oreopithecus* horizon depended on finding and surveying a stratigraphic sequence that was preferably undisturbed by faults such as those that characterize the immediate vicinity of the coal workings at Baccinello.

The small mining community of Baccinello lies in the hill country of the coastal region of Tuscany, some 30 miles distant from the Tyrrhenean Sea and 17 miles east of Grosseto, a provincial capital between Rome and Pisa. Like other coal mining settlements in Tuscany, Baccinello has seen better days—for example, when soft coal mining was profitable, as it was during the last two world wars.

The coal, a lignite, occurs in at least three layers within a basin structure composed of fresh-water and marine sediments regarded as ranging from the middle Miocene to Pliocene (*5*, *6*). The only commercial coal is found close to the base of the sequence, with a thickness varying from 6 to 9 feet (Fig. 1). This constitutes the critical horizon for *Oreopithecus* as evidenced by the latest finds at Baccinello and by the many fossil bones encountered in the same lignite during previous mining operations at Ribolla, Casteani, Aquanera, and Monte Bamboli.

At these places, bones of *Oreopithecus* were found long ago in association with mastodon, *Anthracotherium*, antelopes, *Hyaenarctos*, *Mustela*, *Sus*, crocodilian, and chelonian remains. To those contemporaries of *Oreopithecus* must be added some new forms, still to be identified, that Hürzeler found last summer in the Baccinello lignite: jaw bones of hare and skeletal fragments of snakes

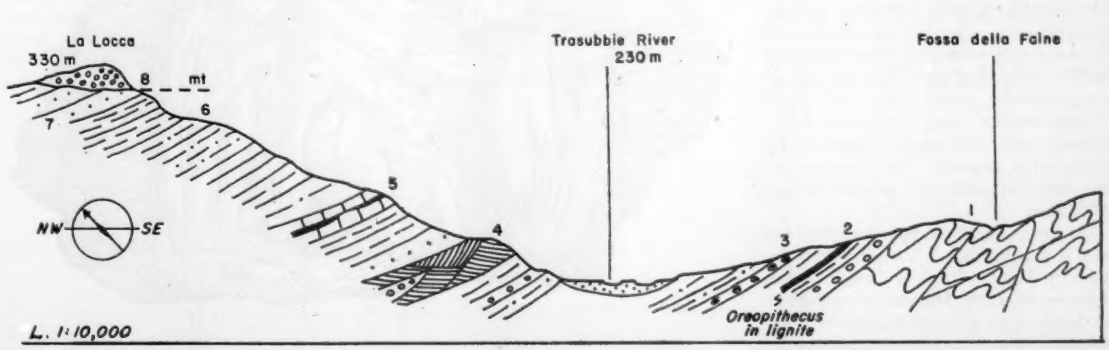

Fig. 1. Geologic sequence with *Oreopithecus* horizon at Baccinello. *1*, "Argille scaliose," marine Cretaceous to (?) Eocene; *2*, conglomerate, sand and lignite with clays and marls; *3*, *Cardium* marl and fine sand; *4*, cross-bedded sand, pebbly sand, and sandy marl; *5*, lacustrine limestone with lignite and shaly marl; *6*, *Hipparion* clay and sandy marl; *7*, pink sandstone and sandy marl; *8*, red conglomerate with oyster banks and fossiliferous marl; *mt*, major marine transgression.

and birds. All these fossils, including those of *Oreopithecus,* bear a black patination. Plant remains are relatively rare and are preserved in fresh-water marls and clays either above or below the lignite. Fresh-water molluscs and ostracods are commonly encountered in the lignite.

A geologic section taken 1 mile northeast of the underground *Oreopithecus* locality at Baccinello (Fig. 1) disclosed a second, if less important, lignite forming a layer but a few inches thick in lacustrine marl containing fresh-water shells and plant remains. A third coal bed was found outside of this region, at Arcille, where a soft, brown coal, up to 8 feet thick, is underlain by marine clay and marl of Pliocene age. Here Hürzeler excavated last year a fauna of fossil land vertebrates with *Myomis,* other rodents, and amphibians.

The paleogeographic conditions that favored repeated swamp formations resulted from coastal basins where temporary ponding of streams was repeatedly interrupted by invasions of the seas. The first invasion was brief, as indicated by a thin marine marl crowded with *Cardium* shells (Fig. 1) and containing some small Foraminifera some 30 feet above the oldest lignite. The second invasion was a major marine transgression that deposited fossiliferous clays and oyster banks over red conglomerates. Derived from terrestrial detritus, these conglomerates rest unconformably on tilted pink sandstone, clays, and fresh-water marls containing teeth of *Hipparion,* the three-toed horse, beaver, and other bones of land vertebrates. Hence the lignite series with *Oreopithecus* and the overlying *Hipparion* clays were tilted prior to this major marine transgression.

Whether these events occurred in the lower Pliocene or in a late phase of the upper Miocene will eventually be decided by identifications of the marine and vertebrate fossils found above the *Oreopithecus* horizon. Following the major marine transgression, the sea claimed this region for a longer time, as indicated by the presence of more than 100 feet of conglomerates, pebbly sands with fossiliferous marine marls and clays intercalated, and subsequently replaced by fresh-water deposits. The thickness of the entire sequence may possibly exceed 1000 feet.

As for the geologic age of *Oreopithecus,* it appears that it was contemporary with the Pontian fauna of Europe (lower Pliocene or upper Miocene, according to a classification adopted in France). Last October Hürzeler reported to me that he had found in the *Hipparion* clay forms such as *Hipparion gracile* Kaup, *Sus choeroides* Pomel, *Antilope gracillima* Weithofer, *Antilope haupti* Weithofer, *Steneofiber jaegeri* Kaup, and further a hare, two kinds of deer, and a primate (? *Oreopithecus*). Since both antelopes and *Sus choeroides* had previously been found in the lignite with *Oreopithecus,* it seems reasonable to assign this form to the lower Pliocene.

Taking into consideration the presence of two fossil primate horizons at Baccinello within an unbroken geologic sequence, there can be little doubt that this region can furnish other important information on *Oreopithecus,* its environment, and its relationships with the Pontian fauna. In this connection, it should be remembered that the lower Pliocene of Europe has furnished a number of higher primate specimens in association with faunistic elements, many of which appear to have been derived from western Asia and Africa.

Oreopithecus Material

The *Oreopithecus* material collected last summer and autumn consists of the following specimens: a nearly complete skull; a portion of the lumbar and sacral sections of the spine; the major articulated portion of a hand; two mandibles, one with eight teeth attached, and the other, while toothless, showing the rounded mandibular symphysis and the high position of the mental foramen; an upper jaw with six teeth and palate intact in addition to the junctions with the zygomatic arch; one fragmentary upper jaw with one molar attached; various skeletal parts and the milk tooth of a child; several isolated foot bones; and diverse finger bones. In addition, Hürzeler was able to obtain from a museum at Siena an important skull fragment from the type locality of Monte Bamboli showing the left orbital region, the right zygomatic arch, the roots of teeth of the right upper jaw, and the occipital portion of the brain case. The skull and jaw fragments were in crushed condition and require careful reconstruction.

The new material is bound to clarify the issue previously raised by Hürzeler concerning the hominid status of *Oreopithecus.* While he is at present preparing a special paleontological report for an American professional journal, I for my part, feel that it is important to relate some translated passages from a letter written on 26 October by G. Heberer, professor of physical anthropology at the University of Göttingen, commenting on the fossil material:

"I visited with Dr. Hürzeler a week ago in Basel and examined the new *Oreopithecus* material. On that occasion we also discussed the previous finds. . . . I have carefully examined the ulna fragment which I cannot help but consider hominoid or even hominid. Unfortunately the new skull is badly crushed and will require much effort at reconstruction. It exhibits nevertheless the absence of a sagittal suture, and a curious divergent alignment of the posterior parts of the zygomatic arches. The eye

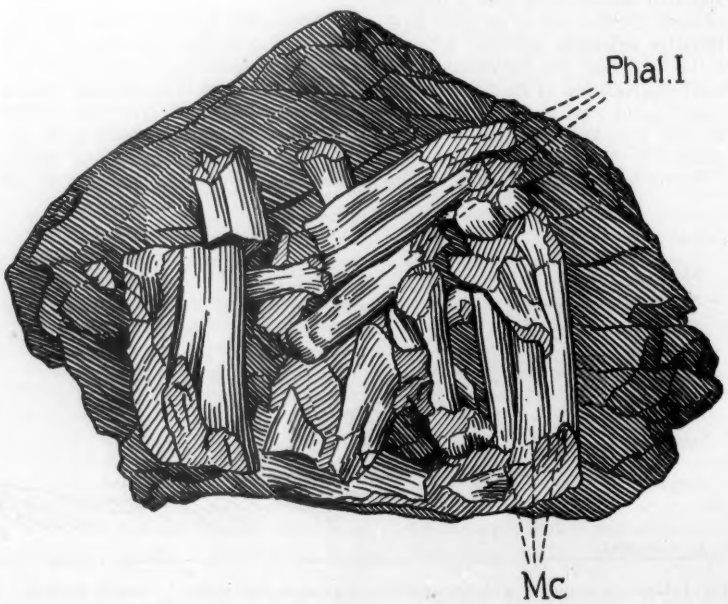

Fig. 2. Articulated portion of a hand of *Oreopithecus* from Baccinello (natural size). Mc, metacarpal; Phal. I, first phalanger.

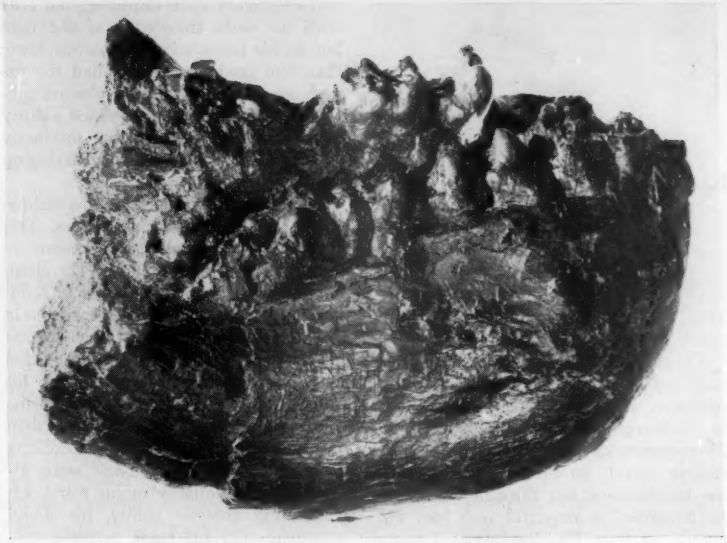

Fig. 3. Lower jaw of *Oreopithecus*. [Courtesy of the American Museum of Natural History]

sockets stood nearly vertical and were not slanted backward. Both of us noticed an angularity of the outer orbital margins. This feature is reserved to the hominids. Of special significance is a portion of the lumbar section of the spine with relatively large vertebrae. This may well indicate that *Oreopithecus* used the hind extremities chiefly for locomotion. Yet this need not necessarily indicate a bipedal gait or a forerunner of it. More comprehensive comparisons will be required to decide this issue.

"The combination of (hominid) features is already so specialized (in *Oreopithecus* as to make their evolution outside of the family of the Hominidae not very likely. . . . Hence my last visit with Dr. Hürzeler has altogether strengthened my belief that *Oreopithecus* is an early hominid of the subhuman phase of hominid phylogeny. In my contribution to *Primatologia* (a new handbook on primates) I have designated the Oreopithecinae as a subfamily of the Hominidae (*7*). On the basis of the new finds I see no reason for changing my opinion. Hence my interpretation agrees rather closely with that of my colleague Hürzeler."

The environment of *Oreopithecus* was undoubtedly that of a warm, humid, swamp forest occupying the lowlands of a hilly landscape adjoining the coast. More specific information can be expected from a chemical, petrologic, and palynologic analysis of the lignite samples collected at Baccinello. These analyses will be carried out by experienced specialists at the Amt für Bodenforschung at Krefeld, Germany (*8*). These investigations will be aided by the paleobotanic studies of Professor E. Tongiorgi of the University of Pisa, and those of Dr. Walter Berger of Vienna who has undertaken a complete revision of a large collection of fossil plants from the lignite of Gabbro in Tuscany (*9*).

Conclusion

The experiences gained in this work demonstrate that we need no longer solely depend for fossil evidence of ancestral primates of Tertiary age on geologic stream-laid formations in which such fossils are scattered in small fragments, but that we now have such localities as Baccinello with local concentrations of skeletal parts in more or less articulated condition. Considering the wide regional occurrence of simian horizons in the younger Tertiary of Europe, the quest for primates ancestral or related to man would now seem to have been placed on a geologic basis more secure and more conducive to new evidence for human evolution than ever before. That such encouraging perspectives are now available is due to Hürzeler's studies, and to all those who aided in this first field season, and in particular to the Wenner-Gren Foundation for Anthropological Research, which subsidized this first investigation.

References and Notes

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2. J. Hürzeler, *Schweiz. Palaeontol. Abhandl.* **66**, 3 (1949).
3. ———, *Verhandl. Naturforsch. Ges. Basel* **65**, 88 (1954).
4. The handicaps caused by conflicting professional duties were partly compensated by the vivid interest of G. Caputo in Florence, the official guardian of antiquities in Tuscany, and by the many helpful aids rendered by C. A. Blanc in Rome. We were very fortunate to find in P. Bertini, a consulting mining engineer of great experience, a man who was full of sympathy with our aims. I am especially grateful also to L. Vonderschmitt, director of the Geological Institute of the University of Basel and acting president of the Geological Commission of Switzerland, and his assistant, L. Hottinger, for their inspection of the crucial field at Baccinello, which resulted in many helpful suggestions. At the coal mine of Ribolla I was greatly aided by Ing. Madotto and his staff of the Montecatini S.A., whose director of mining operations, G. Rostan, lent his good offices for our work.
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R. E. Clausen, Geneticist

Roy Elwod Clausen was born 21 August 1891 at Randall, Iowa, the son of Jens and Matilda Christianson Clausen, both of whom came from Denmark. After graduating from Oklahoma A. and M. College in 1910 with a degree in animal husbandry, he entered the University of California at Berkeley where he obtained his Ph.D. degree in biochemistry 4 years later. In the same year, 1914 he joined the late E. B. Babcock in the newly created division of genetics. With the exception of service in the United States Army, 1917–19, a leave of absence to serve as special consultant in genetics for the Sugar and Pineapple Experiment Stations in Hawaii, 1941, and special duties at the Los Alamos Scientific Laboratory, 1944–45, Clausen spent more than 40 years in teaching and research in Berkeley. His long and distinguished career ended abuptly with his death from a heart attack on 21 August 1956.

Starting with W. A. Setchell's collection of *Nicotiana* species, first in collaboration with T. H. Goodspeed and later with D. R. Cameron, Clausen devoted a lifetime to the study of evolutionary changes within this genus. The origin of the wide range of chromosome numbers within this group of species that gave every indication of descent from a common ancestor attracted and held his attention. From an analysis of chromosome pairing in species hybrids and from the production of the artificial species *N. digluta,* which arose through spontaneous doubling of the chromosomes in the sterile interspecific hybrid *N. tabacum* × *glutinosa,* it was possible to obtain experimental verification of Winge's hypothesis that polyploid species could arise through chromosome doubling in sterile hybrids.

Clausen's pioneering studies on unbalanced chromosomal types—haploids, trisomics, and monosomics—culminated in the recognition of a complete set of 24 monosomics. However, he was not content merely to isolate and describe the monosomics, but through their use he developed a powerful new tool of genetic analysis. He demonstrated how monosomic analysis makes it possible to study, chromosome by chromosome, the genetic differences between the cultivated species *N. tabacum,* a natural allopolyploid, and a series of raw amphidiploids synthesized by doubling the chromosomes of sterile hybrids between putative ancestral species. Through monosomic analysis it was also possible to determine the way in which a gene or group of genes from one species can be incorporated as an integral part of the germ plasm of a second species. Both evolutionary and practical aspects of this transfer mechanism were developed by Clausen and his students.

Although Clausen's main research interest was centered in *Nicotiana,* nevertheless, he carried out extensive investigations on *Drosophila,* particularly the species *D. hydei,* and was interested in the origin and evolution of cultivated plants. The latter was the subject of his Faculty Research Lecture in 1954. Unfortunately, much of this material was never published, owing, in part, to his heavy administrative duties and, in part, to ill health in his later years.

Clausen began his scientific career in that happy period when it was possible for one person to read and digest all the published literature in genetics. Students and colleagues were impressed not only with his wide knowledge of the field but by his penetrating comments. More than one graduate student had the experience of bringing up an obscure subject with him only to be handed a dusty hand-written manuscript that succinctly summarized all that was worth saying on the subject.

For 40 years Clausen gave a unique course of lectures on cytogenetics. This masterly synthesis of developments in the field was revised annually. The chapters on cytogenetics in *Genetics in Relation to Agriculture,* which was written in collaboration with E. B. Babcock, first published in 1918 with a second edition in 1927, represent two revisions of his course. Students frequently repeated the course, some of them even more than once, and found that it was an exciting experience each time. They were attracted by the quality of his mind, his penetrating analytic ability, his sound judgment, and his clear, unemotional, and well-organized presentation. His solid worth was recognized by all who knew him, and to many of his students he was the ideal scientist.

Because of his ability, modesty, and devotion to duty, Clausen held numerous offices in scientific societies, including vice president and chairman of the Pacific Division of the AAAS, secretary-general of the sixth Pacific Science Congress, and president of the Genetics Society of America. Through his long years of service on faculty and administrative committees, particularly the Committee on Budget and Interdepartmental Relations, he played a major role in directing the affairs of the university. These exacting duties, together with his service at Los Alamos, adversely affected his health. Although he tried to avoid administrative duties on his return to Berkeley, he was persuaded to serve as chairman of the department of genetics, which he did for the last 9 years. His election to membership in the National Academy of Sciences and his selection by fellow-faculty members to give the Faculty Research Lecture at the University of California were well-deserved honors.

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Department of Genetics,
University of California, Berkeley

News of Science

Solar Distillation of Saline Water

Progress in the development of economical means of utilizing solar energy to convert salt water to fresh water in arid regions has been reported by the U.S. Department of the Interior. Research conducted by the department's Office of Saline Water since 1953 has shown that the use of heat from the sun to distill salt water has promise of economical large-scale fresh production. This is particularly true in the Southwest, where solar intensities are high, provided that simple stills can be made inexpensively enough, or the productive capacity of stills greatly increased, or both.

One means of increasing output is by multiple-effect distillation in which the heat absorbed in evaporation is recaptured in condensation and made to evaporate additional water, according to David S. Jenkins, director of the Office of Saline Water. Maria Telkes of New York University, working under a contract with the department, has developed a ten-effect solar still based on an earlier patent by Defoe Ginnings of the National Bureau of Standards. The device requires no expensive mechanical equipment and, from a given area exposed to sunshine, can produce about 6 times as much fresh water as a single still.

The principle can be used also with other forms of low-grade heat. Telkes has also been developing an improved tilted single-stage solar still for the department. Larger units and field testing now are needed on both types.

A possible way to reduce costs is to use plastic materials with specially designed properties. Departmental studies conducted through the Bjorksten Research Laboratories of Madison, Wis., have shown that plastic materials are feasible, provided that transparent materials which can withstand at least 3 years of outdoor weathering can be developed. Many materials have been tested but without success.

Recently, however, several new types of materials have become available in experimental quantities from the Du Pont Company. For example, it is reported that a new type of transparent film of tetrafluorethylene resin will withstand an estimated 10 years of outdoor exposures.

A solar-still design envisioning a heavy, black plastic base or evaporation pan, with a transparent plastic film supported only by slightly increased air pressure—without rigid supports—has been proposed by Du Pont. The sun's energy is trapped between the plastic base and the transparent canopy.

Under an agreement signed recently between the Department of the Interior and the Du Pont Company, the company will provide materials for construction of prototype stills approximately 2 feet wide and 100 feet long for experimental tests on salt-water conversion. The stills will be constructed and operated by the Federal Government.

In addition, the company will supply to the department or a few of its cooperators, which the department may designate, small samples of the film for small-scale laboratory tests on solar stills. Cooperators include the governments of Spain, Morocco, and Algeria.

Another means of reducing costs of simple solar stills is being developed for the department by George O. G. Lof of Denver, Colo. A roof-type still built directly on the ground, eliminating some framing and insulation, is expected to operate at night from heat stored in the ground during the day. An experimental still covering about one-tenth of an acre at the seashore location is being prepared for the study of night radiation. The Du Pont and Telkes stills also will be tested at the seashore location.

AAAS Theobald Smith Award

Oscar Touster, associate professor of biochemistry at the Vanderbilt University School of Medicine, is the winner of the 1956 AAAS Theobald Smith award in the medical sciences. This annual award, which was established in 1936 by Eli Lilly and Company, consists of $1000, a bronze medal, all travel expenses to and from the AAAS annual meeting, and all expenses at the meeting for the week of its duration, 26–30 Dec. This year's presentation will be made by Irvine H. Page, director of research for the Cleveland Clinic and chairman of the AAAS section on medical sciences, at 9 A.M. on 30 Dec. in the ballroom of the Hotel Statler, New York.

The award is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." The recipient must be a U.S. citizen who is less than 35 years of age on 1 Jan. of the year in which the award is to be made.

Touster's major and most recent work has been on the underlying cause of congenital pentosuria, a rare genetically determined metabolic abnormality in human beings that is characterized by the excretion of large amounts of a rare pentose sugar called L-xylulose. Years ago the condition was frequently mistaken for diabetes.

Using refined analytic techniques, Touster was able to detect the production of the pentose sugar in guinea pigs and in apparently healthy normal human beings. Since the then current knowledge of biochemistry could not explain the widespread ability to form the sugar, Touster further investigated its metabolism and discovered liver enzymes whose actions provide an understanding of the normal metabolic pathway of the sugar and an insight into the enzymatic deficiency in pentosuric individuals. The results of Touster's research on pentosuria, as well as on bacterial metabolism and organic chemistry, have been published in articles in medical and chemical journals and in contributions to scientific books.

Radiationproof Photosensitive Plastic

The Army Signal Corps has announced the development of a photosensitive plastic that can be used for printing photographs in areas affected by atomic radiation. The new process is almost unaffected by gamma rays. The pictures are clear, durable, waterproof, and stronger than ordinary paper prints, which tend to fog under nuclear radiation.

The process, originated by the Ferro Chemical Company of Bedford, Ohio, employs a minimum of equipment. No water, chemicals, or darkroom are needed. A sun lamp takes the place of an exposure light, and an oven replaces trays of hyposulfite and developing solutions. Printing of the picture is accomplished in 5 minutes.

Ten Unitarian Church Services Coordinated with AAAS Meeting

In recognition of the 123rd annual meeting of the AAAS in New York, ten Unitarian churches in the metropolitan area will observe "Religion and Science Sunday" on 30 Dec. Ministers will address their congregations on the cordial relations between liberal religion and sci-

ence and indicate the lack of conflict between progressive religion and the spirit of contemporary science.

Churches taking part in the observance follow: the Community Church, Manhattan [*Science* **124**, 1196 (14 Dec. 1956)]; the Unitarian Church of All Souls, Manhattan; the First Unitarian Church, Flushing, Queens; the Hollis Unitarian Church, Queens; the Unitarian Church of Staten Island, Richmond; the First Unitarian Church, Yonkers; the North Shore Unitarian Society, Plandome; the Unity Church, Montclair, N.J.; the First Unitarian Society, Plainfield, N.J., and the First Unitarian Church, Trenton, N.J.

AAAS Election Results

Yesterday at the annual meeting of the AAAS it was announced that Wallace R. Brode is the 1957 president-elect of the association. Brode, who is associate director of the National Bureau of Standards, was first elected to the AAAS board of directors in 1953.

George W. Beadle, chairman of the division of biology at California Institute of Technology, is succeeded as retiring president of the association by Paul B. Sears, chairman of the Yale Conservation Program at Yale University. Alan T. Waterman, director of the National Science Foundation, is a new member of the board, and Paul Klopsteg, associate director of NSF, was reelected to membership.

Industrial Use of Agricultural Products

Appointment of an 11-member Oilseeds and Animal Fats Task Group to advise the President's bipartisan Commission on Increased Industrial Use of Agricultural Products has been announced. The first meeting of the task group took place in Chicago, Ill., on 28 Nov., according to the group's chairman, James C. Konen, vice president in charge of research, Archer-Daniels-Midland Company, Minneapolis, Minn. The task group will review the technical economic position of oilseeds and animal fats. On the basis of this study, the group will submit an advisory report for consideration by the commission in making its recommendations to Congress concerning legislation designed to increase industrial uses of farm products.

Another of the commission's advisory groups, the nine-member New and Special Crops Task Group, held its first session in Washington, D.C., 15–16 Nov. At the meeting, emphasis was placed on new and special crops that could be grown on acreage customarily used for wheat and cotton—two of the nation's major surplus crops. The task group underlined the need for analyzing the chemical makeup of new crops that yield fiber, protein, oils, drugs, gums, and other carbohydrates to determine how they may be used industrially.

Hungary

■ On Human Rights Day the governing board of the National Research Council of the National Academy of Sciences announced that its resources were available to refugee Hungarian scientists who wish to find opportunities to continue their scientific work. The Academy–Research Council also will make every effort to aid the many academic and scientific institutions and governmental agencies that desire to assist Hungarian scholars who have been denied the opportunity to continue their work in freedom.

By unanimous resolution the NRC board also paid high tribute to those scientists still remaining in Hungary who have shown such courageous devotion to the principles and freedom necessary for the furtherance of science. In addition, the board endorsed the resolutions adopted recently by its mother academy and by the American Philosophical Society. The NAS resolution follows:

> "Those members of the National Academy of Sciences of the United States of America present at a meeting in Washington unite in expressing their profound admiration and sympathy to fellow scientists in Hungary and to all the men and women of that nation who have demonstrated their love of liberty with sacrificial devotion during the tragic events of the past few weeks. American scientists look forward with hope to a time when their Hungarian colleagues, freed from external oppression, will be able to join fully in the international exchange of information, discussion and encouragement which is essential to the progress of science."

The statement adopted by the American Philosophical Society read:

> "The American Philosophical Society regards with greatest concern the events of recent weeks in Hungary. The members of the Society, assembled in Executive Session in Philadelphia, declare the greatest admiration for the people of Hungary in their defense of freedom and express profound sympathy for the tragic suffering which they have so resolutely endured. The members of the Society look forward with confidence to the time when free intellectual exchange with the Hungarian people and between all the peoples of the earth will be firmly re-established."

Ford Foundation and Fund for Education Combined

The Ford Foundation has announced that its activities in the field of education and those of the Fund for the Advancement of Education will be combined after 1 Jan. Clarence H. Faust, president of the fund, will become a vice president of the foundation, and as such will be in charge of all educational programs. He will continue as president of the fund during the period of expenditure of the remainder of the $25 million granted to the fund by the foundation in 1954.

William McPeak, vice president of the foundation, will give up his supervision of the foundation's educational program. He will continue to be in charge of behavioral science and the humanities and will undertake the development of new programs.

Faust will draw on the officers and staff of the fund to work on the educational program of the foundation during the transitional period. Directors of the fund will continue to exercise full responsibility for the fund's program, and they will also advise the foundation on the concurrent development of the foundation's over-all program in education.

Index to Science

Following the practice started with volume 123, the volume index to *Science* will henceforth appear in the fourth issue of the month following the close of a volume. The index for volume 124, July–December 1956, will appear in the issue of 25 Jan. 1957.

News Briefs

■ On 6 Jan. CBS Television will introduce a new weekly program, "Odyssey," the story of man's pursuits from prehistoric times onward. In cooperation with the world's museums, the program will deal with fields as varied as art, literature, music, geology, zoology, industry, medicine, metaphysics, and the circus. "Odyssey" will be produced by Charles Romine for CBS Public Affairs, in cooperation with the American Association of Museums. Associate producers are Ted Sack and Frank De Felitta.

■ The U.S. Army Signal Corps and the Bell Telephone System have opened an important communications link between the United States and the Territory of Alaska, an underwater telephone cable system stretching some 1250 miles from Port Angeles, Washington, to Skagway, Alaska. Hatfield Chilson, Assistant Secretary of Interior, and B. Frank Heintzleman, Governor of Alaska, talked together on the first call over the new system. The

call utilized a 4600-mile telephone network that joined Washington and Juneau and included Seattle, Ketchikan, Anchorage, and Fairbanks. At each location, government, military, and industrial officials participated in the inaugural ceremonies.

■ The crater of the active volcano of Izalco, in western Salvador, has been observed and photographed at close range for what is probably the first time. On 23 Nov. six men, led by Haroum Tazieff, French volcanologist, climbed to the crater's edge, where they remained for 20 minutes. They gathered samples of volcanic rock to be sent to Paris for geological study, and they also made a film. The expedition was under the auspices of the United Nations Educational, Scientific, and Cultural Organization.

Scientists in the News

GEORGE R. HARRISON, dean of science at Massachusetts Institute of Technology, has been chosen to receive the first Pittsburgh spectroscopy award, which has been established by the Spectroscopy Society of Pittsburgh to honor those who have made distinguished contributions in this field of science. The presentation will be made on 6 Mar. 1957 at the dinner for the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy.

Among Harrison's outstanding achievements are his numerous studies of line spectra, the measurements and compilations for the *M.I.T. Table of Wavelengths,* important contributions to the ruling of gratings, authorship of several books, and 10 years' service as editor of the *Journal of the Optical Society of America.* He has been a leader in establishing the analytical use of emission spectroscopy, and he has been a teacher throughout most of his lifetime.

ROBINSON BROWN, senior mechanical engineer at Southwest Research Institute, has been appointed head of the newly created mechanical development section of the department of engineering mechanics. The new section, which will be under the general direction of EDWARD WENK, JR., chairman of the department of engineering mechanics, will work on research and development problems related to oil field and heavy equipment for industrial research sponsors.

RURIC C. ROARK, who for nearly 30 years was in charge of U.S. Department of Agriculture research on insecticides and other pesticidal chemicals, retired from Government service on 1 Dec. His successor as head of the pesticide chemicals research section in USDA's Entomology Research Branch is Stanley A. Hall, formerly leader of the Branch's project on synthesis of organic insecticides, synergists, and insect repellents and attractants.

During almost 43 years of work for the department, Roark has won wide recognition for his important contributions to the development of insecticidal fumigants for agricultural products, the development and adoption of rotenone-containing insecticides, and for his leadership of research on insecticide residues. His compilations of information and annotated bibliographies on insecticides have been of outstanding value to scientists throughout the world.

Roark attended Kentucky State University, Clark College at Worcester, Mass., and the University of Cincinnati, where he received his B.A. degree in 1907. He did graduate work in organic chemistry at the University of Illinois (M.A. 1908), the University of Wisconsin, and George Washington University, Washington, D.C. (Ph.D. 1917).

In 1948 the Department of Agriculture presented a Distinguished Service award to Roark's unit, and in June 1956 Roark was honored with USDA's Superior Service award for "inspirational leadership and meritorious service to agriculture in developing and improving the use of chemical control methods for insect pests."

In addition to his contributions to agriculture, Roark has been responsible for chemical research on insect-control materials important to national defense. In 1946 the Surgeon General of the Navy commended Roark and his staff for exceptionally meritorious service rendered to the naval forces during World War II.

WILLIAM C. MENZIES, JR., of the Celanese Corporation of America's development engineering laboratories in Charlotte, N.C., has been appointed technical director of the Lowell Technological Institute Research Foundation, Lowell, Mass. He succeeds GEORGE O. LANGLAIS who has accepted a position in technical services with the Monsanto Chemical Company in Springfield, Mass.

JANE STAFFORD, who for many years has been associated with Science Service, where she has been in charge of writing about the medical sciences, has accepted a science writing position at the National Institutes of Health in Bethesda, Md. On 3 Dec. she became assistant for research reports in the Office of Research Information, which has responsibility for the collection, preparation, and dissemination of information related to the medical and biological sciences. Miss Stafford is a senior member of the writing and reporting staff at NIH.

DAEL L. WOLFLE, executive officer of the AAAS, received an honorary degree during the 65th Founder's Day convention at Drexel Institute of Technology. Other recipients of honorary doctor of science degrees were Catherine MacFarlane, research professor in gynecology at Woman's Medical College; John S. Burlew, executive vice president of the Franklin Institute; and Merriam H. Trytten, director, Office of Scientific Personnel, National Research Council.

ARTHUR E. RUARK, Temerson professor of physics at the University of Alabama, has been granted leave by the university in order to join the research division of the Atomic Energy Commission in Washington, D.C. In January he will become chief of the controlled thermonuclear branch.

C. P. OLIVER and W. S. STONE, department of zoology, University of Texas, Austin, will assume the managing editorship of *Genetics,* beginning with the volume for 1957.

BERNARD B. JATUL has been named director of the pharmaceutical chemistry research department of the Schering Corporation, Bloomfield, N.J. He succeeds RICHARD BARRY, who has been named vice president and scientific research director of the Union Pharmaceutical Company, an affiliate of Schering.

HEINZE FRANKEL-CONRAT of the Virus Laboratory of the University of California, will deliver the third annual Margaret Beattie lecture of the American Association of Bioanalysts (Western Region), which is scheduled for 3 Feb. at the St. Francis Hotel in San Francisco, Calif.

COMFORT A. ADAMS of Philadelphia, Pa., electrical engineer and Harvard University professor emeritus, has been awarded the 1956 Edison medal. It will be presented during the winter general meeting of the American Institute of Electrical Engineers at the Hotel Statler, New York, 21–25 Jan. Adams is being honored "for pioneering achievements in the development of alternating current electric machines and in electrical welding; for vision and initiative in the formation of an engineering standards organization and for eminence as an educator and consulting engineer."

C. LLOYD CLAFF has been appointed research associate in the department of biology, Boston University, College of Liberal Arts. He is president of the Single Cell Research Foundation, Inc., Randolph, Mass., and research associate in surgery in the Harvard University Medical School.

PAUL D. WHITE, emeritus professor of medicine at the Harvard Medical School, will deliver the 32nd Hermann M. Biggs memorial lecture, under the auspices of the Committee on Public Health of the New York Academy of Medicine, on the evening of 7 Feb. in the academy building. He will discuss "The relation of ways of life to heart disease."

WILLIAM CULSHAW, an English physicist who has successfully applied optical methods to study of millimeter radio waves, has joined the Boulder Laboratories of the National Bureau of Standards to continue this work, which he will carry out in the microwave physics section. Before joining the Bureau, Culshaw was with the millimeter wave division of the British Telecommunications Research Establishment, where he specialized in microwave optics and later in millimeter wave magnetron development.

Recent Deaths

KARL GEBHARD, Winter Park, Fla.; 64; former attending surgeon at Mount Vernon Hospital and former instructor in anatomy at Bellevue Hospital; 9 Dec.

FLORENCE HEDGES, San Francisco, Calif.; 78; retired plant pathologist who worked with the U.S. Department of Agriculture for more than 30 years; 11 Dec.

ROGER I. C. MANNING, Phoenix, Ariz.; 57; director of the Arizona Department of Mineral Resources since 1951; 8 Dec.

JEFFREY R. STEWART, Franconia, Va., and Fort Lauderdale, Fla.; 51; paint specialist, operator of his own research laboratory, editor and publisher of the *National Paint Bulletin*; 9 Dec.

CARL V. WELLER, Ann Arbor, Mich.; 69; editor of *The American Journal of Pathology* since 1941 and chairman of the University of Michigan department of pathology for 25 years; 10 Dec.

Education

■ The University of Wisconsin's board of regents has approved plans for a research observatory to be located 15 miles west of Madison. A new building, together with a 53-acre site and a new telescope, are being made available through a $200,000 gift to the University from the Wisconsin Alumni Research Foundation.

The telescope, a 36-inch reflecting instrument, is under construction at Boller and Schwens, South Pasadena, Calif. The firm expects to make delivery sometime late in the summer of 1957. The new telescope will provide 5 times the light-gathering power of the university's Washburn Observatory telescope, a 15-inch refracting instrument in use for almost a century.

■ The second in a series of grants in support of computation centers and research in numerical analysis has been announced by the National Science Foundation. Grants totaling $230,000 have been awarded as follows: Cornell University, $50,000; University of California (Berkeley), $50,000; University of Pennsylvania, $70,000; Princeton University, $40,000; and Stanford University, $20,000.

■ The Warren Building of the Massachusetts General Hospital, Boston, was dedicated on 3 Dec. "as a tribute to the members of the Warren family for their contributions to the medicine and surgery of the new world." Three floors of the $4-million facility will house the pathology department, and four others will be devoted to clinical and research laboratories for neurology, neurosurgery, psychiatry, and dermatology. In addition, the new building eventually will provide patient areas. Originally designed as a five-story building in 1951, the plans were revised in 1955 for a 12-story structure.

■ The department of microbiology at Saint Louis University School of Medicine has been reorganized under the direction of R. Walter Schlesinger, formerly at the Public Health Research Institute of the City of New York, Inc. The department has undergone complete physical reconstruction, especially of its research facilities.

■ The Veterans Administration Hospital, Madison, Wis., has announced the establishment of a radioisotope laboratory for basic biochemical and clinical research, with emphasis on research on the biosynthesis and metabolism of lipids. Support for the work will be administered through the University of Wisconsin Medical School and the Veterans Administration. Laboratory research will be under the direction of John W. Porter, and clinical investigations will be supervised by Frank C. Larson. A limited number of pre- and postdoctoral appointments will be available through the University of Wisconsin for applicants interested in this work.

Grants, Fellowships, and Awards

■ The Daniel and Florence Guggenheim Foundation has announced that 18 to 20 fellowships for graduate study in the fields of jet propulsion and flight structures will be awarded in 1957 by the Daniel and Florence Guggenheim jet propulsion centers at Princeton University and the California Institute of Technology and by the Institute of Flight Structures at Columbia University. The stipends range from $1200 to $2000 each, plus tuition.

Application forms are available from the presidents and deans of all engineering and technical colleges; presidents, plant managers, and personnel directors of all companies, laboratories, and engineering organizations known to be engaged in rocket, jet propulsion, or flight structures work; commanding officers of armed forces units and establishments engaged in rocket and jet propulsion development and testing; secretaries of the principal technical societies; and from the Daniel and Florence Guggenheim Foundation, 120 Broadway, New York, N.Y., as well as from Princeton, C.I.T., and Columbia.

■ Entries are now being accepted for the Oberly memorial award that is presented every 2 years by the American Library Association for the best bibliography in the field of agriculture or the related sciences. The current award, to be made at the ALA annual conference in Kansas City, 23–29 June, is for a bibliography issued in 1955 or 1956. Final entry date is *15 Mar. 1957*.

Seven copies of the bibliography should be sent to Whiton Powell, Chairman, Albert R. Mann Library, Ithaca, N.Y. An accompanying letter should state that the work is being submitted for consideration for the Oberly award and that the authors are United States citizens. Copies will be returned after the competition if so requested at time of submission. Points to be considered in judging will be accuracy, scope, usefulness, format, and special features such as explanatory introductions, annotations, and indexes.

■ The Lalor Foundation has announced details of the 40 awards that it is offering to younger college and university staff and faculty members for research in the biological sciences for the summer of 1957. This is the third annual series of such summer research awards.

The awards are for advanced study and research employing chemistry or physics to attack problems in any field of biology. The studies may be carried on at any institution of the award holder's choice. The upper age limit for appointment is 40 years.

The awards will usually not exceed $900 for a single man or woman, $1100 for a married person working at his home institution, and $1250 for a married person whose principal program is at another institution. Transportation and other expenses are for the account of the award holder.

In recent years the foundation has maintained a number of postdoctorate summer fellowships at the Marine Biological Laboratory at Woods Hole, Mass. With the consolidation of these fellowships into the present program, it is suggested that men and women interested in work at M.B.L. and eligible under the Lalor faculty summer award plan should submit applications under this newer program.

Inquiries respecting Lalor Faculty Summer Research awards should be addressed to the Director of the Lalor Foundation, 4400 Lancaster Pike, Wilmington 5, Del. Final date for receipt of completed applications is *14 Jan. 1957,* and notification regarding appointment may be expected by 15 Mar.

■ The National Society for Crippled Children and Adults has announced that 20 fellowships for specialized training in working with cerebral palsied and other severely handicapped persons are available. A training program will be held 17 June to 12 July at the Institute of Physical Medicine and Rehabilitation of the New York University–Bellevue Medical Center.

The deadline for receipt of applications is *15 Mar.* Qualified counselors and placement workers in public and private agencies interested in vocational problems of the crippled are urged to apply immediately for the fellowships, which will cover tuition and moderate living expenses. Six points of academic credit at the graduate level will be given to those who successfully complete the course. Application blanks can be obtained from the National Society for Crippled Children and Adults, 11 S. LaSalle Street, Chicago 3, Ill.

■ The Division of Biological and Medical Sciences of the National Science Foundation has announced that the next closing date for receipt of research proposals in the life sciences is *15 Jan. 1957.* Proposals received prior to that date will be reviewed at the winter meetings of the foundation's advisory panels, and disposition will be made approximately 3 months following the closing date. Proposals received after 15 Jan. will be reviewed following the spring closing date of 15 May 1957.

■ The U.S. Public Health Service has announced 44 5-year research fellowship awards to scientists in 29 universities and medical schools in 20 States, the District of Columbia, and Canada. The awards are the first in a new federal program designed to increase manpower for research in the basic medical sciences.

Recipients are scientists who have completed their doctor's degrees in biochemistry, pharmacology, physiology, microbiology, pathology, and the psychological sciences. Each fellow will receive a salary not to exceed $10,000 yearly, plus up to $2000 to defray part of the expenses of his research. The salary level is set by the institution to approximate the salaries of scientists doing similar research and teaching as members of the regular faculty.

These fellowships will permit recipients to continue their research activities. Concurrently, the sponsoring institutions will assign appropriate teaching responsibilities so that fellows may qualify for full-time academic positions at higher levels.

In citing the need for the senior fellowships, the Surgeon General of the USPHS, Leroy E. Burney, said a recent survey showed that for the current year more than 200 authorized and budgeted positions on the faculties of medical and basic science schools are unfilled. Included are 55 professorships, 52 associate professorships, and 79 assistant professorships. An equivalent number of vacancies existed last year.

The USPHS will award between 40 and 50 new fellowships annually until approximately 250 have been given by the fifth year. Thereafter the program will be maintained at this level until the national deficiencies have been met. The total cost of the first year of the program will be in the neighborhood of $500,000.

Miscellaneous

■ *Medical History,* a new British quarterly, will begin publication on 1 Jan. 1957. Each issue will contain approximately 100 pages of text together with illustrations. The journal will be the official organ of the Cambridge University History of Medicine Society and the Scottish Society of the History of Medicine.

The purpose of the new journal is to provide a medium for the publication of papers in all fields of the history and bibliography of medicine and its related sciences, as well as on the wider aspects of medical humanism. Particular emphasis will be placed on the correlation of historical studies with present-day practice and research. There will be sections devoted to the proceedings of medico-historical clubs and societies, the publication of original texts and documents, notes and news, questions and answers, abstracts and book reviews.

The journal will be international in its scope, and is designed to appeal to the growing number of doctors and students who are interested in medical history as well as to librarians and bibliophiles.

The interests of librarians and of book collectors will be especially catered to by the regular inclusion of bibliographical studies, descriptions of rare and important books, news relating to medical libraries and collections, and periodical reports on important sales and book prices.

Contributions, which may be of any length up to about 10,000 words, are invited. They may deal with any aspect of medical history or medical bibliography, biography, iconography, history of medical institutions, education, famous patients, medicine in art and literature, truants from medicine, and so forth. Manuscripts should be sent to the editor, W. J. Bishop, Medical History, c/o Wm. Dawson and Sons, Ltd., 4 Duke St., Manchester Square, London, W.1. England.

■ Harvard University's Atkins Garden and Research Laboratory, which is in Cienfuegos, Cuba, has reported that in the first week of October six large clumps of *Dendrocalamus strictus* (Roxb.) Nees, an economically important bamboo of southern Asia, began to flower at the station.

On being informed of this event, F. A. McClure, specialist on bamboos, wrote the garden that flowering probably would continue for several months and that some seed would be produced before the clumps die. He indicated the desirability of detailed studies on all phases of the flowering and fruiting of this species, especially the developmental morphology, anatomy, and caryology. Should viable seed be set, a whole new array of investigations is possible in the fields of botany, horticulture, and reforestation.

Since material of this kind is rarely available to American investigators, the Atkins Garden is prepared to fill requests for study materials. Detailed instructions should be sent with such requests, and, if fixed material is desired, the fixative should be sent in vials by first-class airmail. Herbarium material is being prepared and will be available for distribution later. For further information, write to I. D. Clement, Atkins Garden and Research Laboratory of Harvard University, Apartado 414, Cienfuegos, Cuba.

■ Included in the January issue of *The Scientific Monthly* are four of the papers presented at a symposium, "Uses and effects of atomic radiation," held in connection with the dedication of the new headquarters building for the American Association for the Advancement of Science. These are "Radiation and the human body," S. Warren; "Radiation and genetics," L. C. Dunn; "Uses of atomic radiation and energy," L. R. Hafstad; and "What we most need to know," L. H. Snyder. Also included are "Dedication of the new AAAS headquarters building," P. B. Sears; "Role of statistics in scientific research," J. W. Mayne; "Political science of science," H. D. Lasswell. Twelve books are reviewed.

Reports

Nonexistence of Gravity Shields

Electric forces exhibit sign reversals that can be associated with plus and minus signs for elementary charges. In considering gravitational effects upon antimatter, it is essential to know whether a similar sign change occurs for gravitational forces. This note gives an elementary argument for a negative conclusion—namely, the dominant gravitational force between matter and antimatter is attractive, just as between matter and matter. This conclusion may be of significance for cosmological speculation involving antimatter (*1*).

The following discussion involves two approximations: the gravitational field is considered as weak, so that distortion of space-time can be neglected; and relative velocities are supposed to be small, so that only the static interaction terms need be included. Both approximations are appropriate to most practical applications of gravitation. Under these approximations, the electromagnetic and gravitational interactions between two systems assume identical forms:

$$V = -\int\int d^3r_2\rho_1(r_1) \varphi(|r_1 - r_2|)\rho_2(r_2)\, d^3r_2 \quad (1)$$

Here φ is a function exclusively determined by the properties of the gravitational or electromagnetic field transmitting the interaction from r_1 to r_2, and ρ_j is an appropriate density junction for system j. In the static approximation $\varphi(x) = x^{-1}$ for both gravitational and electromagnetic fields, since both are massless. The quantities ρ_j are different for the two cases, however: the charge density is the fourth component of a 4-vector, while the matter density is the double-fourth component of a second-order tensor.

In the weak-field approximation, the interaction between gross aggregates of matter is the sum of the interactions between their constituent elementary particles (nucleons and electrons). Thus the behavior of V for gross matter is determined by its behavior for elementary particles. In quantum mechanics, the essential step in transforming from a particle to an antiparticle is the operation of complex conjugation, where the associated conventional coordinate system is (x, y, z, ict). Thus complex conjugation is also associated with reversal of the sign of t and of all 4-components; the charge density ρ_j will hence change sign upon substitution of antimatter for matter, while the matter density will not, having the signature $(-1)^2 = +1$.

Another statement of this conclusion is that "gravitational charge" has only one sign. This immediately negates the possibility of a shield for gravitational forces: the action of an electric shield depends on the separability of two types of charge with opposite sign. This result may be limited by the approximations stated but should certainly be valid for all terrestrial applications.

This argument obviously extends to fields of any intrinsic multipolarity: if two particles interact through the mediation of an nth order tensor field (*2*), the associated static potential will or will not suffer sign changes for antiparticles, according as n is odd or even. Association of the imaginary factor i with the time coordinate characterizes a second alternation of sign between even and odd n. For like charges, $(\rho_1\ \rho_2)$ has a factor $(i)^{2n} = (-1)^n$; with the additional minus sign in Eq. 1, like charges are repulsive for odd n, attractive for even n. Hence attractive static potentials are possible for any n, but repulsive potentials occur only for odd n.

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References and Notes

1. For example, M. Goldhaber, *Science* **124**, 218 (1956).
2. Pseudotensor fields are excluded from consideration, for they yield a vanishing interaction in the static approximation.

19 November 1956

Sulfhydryl Groups and Cell Division

The idea has long been held that sulfhydryl groups are particularly important in cell division. Support for this idea has come from three lines of evidence, all established by early investigators (*1, 2*): the strong nitroprusside reaction of a number of proliferating tissues; the inhibition of division by thiol poisons and its reversal by cysteine, glutathione, or thioglycollate; and the fall and rise in concentration of soluble thiols prior to first cleavage in the fertilized sea-urchin egg.

On the basis of these observations, Rapkine (*1*) proposed a theory of division in which a reversible denaturation of protein and a reduction of oxidized glutathione were the key mechanisms. In Rapkine's scheme, protein denaturation was the primary event that had to precede division since it was by the resultant exposure of the —SH radicals that the intracellular store of oxidized glutathione was reduced. The glutathione thus formed altered the oxidation-reduction level of the cell so as to effect a fermentative metabolism leading to division.

Later, Brachet (*3*) pointed out that the oxidation of protein —SH to the disulfide could be given in addition a structural function by relating the disulfide linkage to the formation of the mitotic spindle. Recently, Mazia (*4*) dismissed the idea that the changes in soluble sulfhydryl concentration were related to metabolic shifts in the dividing cell. Instead, he interpreted the fall and rise in soluble sulfhydryl concentration as resulting from the formation and dissolution of the spindle elements. To support this interpretation, he presented preliminary data showing that at the time of spindle formation in the fertilized sea-urchin egg, protein —SH was at its lowest and soluble thiol at its highest concentration, and that throughout the cycle from fertilization to first cleavage, protein —SH and soluble —SH were in reciprocal concentrations.

It is the purpose of this communication (*5, 6*) to report briefly some analytic results that have a bearing on these speculations. Developing anthers of a lily (*Lilium longiflorum* var. Croft) were analyzed for their content of soluble and protein sulfhydryl during an 11-day interval surrounding the mitosis of the microspores. It is possible to determine the interval easily because of Erickson's demonstration that the length of a flower bud is correlated with the synchronous divisions of the germinal cells in the anther (*7*). At 41 mm, these cells are all present as young microspores; at 62 to 63 mm, the mid-point of the interval studied, they undergo mitosis to yield binucleate pollen cells, the only quick and marked change between 41 and 180 mm, the time of anthesis.

During this interval, the microspores and pollen are the principal components of the anthers. They differ from the much studied sea-urchin egg in at least two important respects: (i) they do not have the extraordinarily low nucleo-cytoplasmic ratio of the newly fertilized egg in which cytoplasmic changes (the growth and disappearance of the spermaster, for example) could well obscure changes directly related to nuclear division and (ii) they do not undergo cytoplasmic cleavage. Since such cleavage is

generally accompanied by sol-gel transformations, the possibility that the measured changes in protein —SH are due to this purely cytoplasmic event is eliminated in analyses of the anther.

The cycles of thiol concentrations associated with microspore mitosis are illustrated in Fig. 1. The solid line represents the total acid-soluble —SH and —SS— as determined by amperometric titration after electrolytic reduction of the extracts. It can be seen from the values for —SH alone (determined on the same extracts before reduction) that there is no conversion of —SS— to —SH preceding mitosis such as is postulated by Rapkine. Parallel determination of glutathione content of the extracts by the glyoxalase technique revealed the same cycle of variation as that found by the amperometric method. The soluble —SH was largely, though not entirely, glutathione.

The results are thus in agreement with the generalization of Rapkine that soluble thiol compounds increase prior to cell division. The source of such thiol is not, however, in a reservoir of soluble disulfide. On the contrary, there is an absolute increase in the concentration of glutathione preceding mitosis, and this high concentration persists until well after mitosis is completed. Variations of a smaller order of magnitude have been noted during the mitotic period, but because they have not yet been satisfactorily established they are omitted from the figure. Since formation and dissolution of the spindle occurs during mitosis and, since the high concentration of —SH extends well on both sides of the mitotic cycle, the idea that the concentration of glutathione varies directly as the degree of gelation of the spindle body cannot have general application. Indeed, by comparing the curves for protein and soluble —SH, respectively, it can be seen that in lily microspores the two components do not bear a reciprocal relationship to one another.

In one respect, the results obtained are consistent with earlier studies on marine eggs and protozoans: the association of an intense nitroprusside reactivity with the process of cell division. To this we can only add that the reactivity is, in fact, largely due to glutathione. There is no indication from the data concerning how the increase in soluble sulfhydryl occurs. The most probable explanation is that there is a synthesis of the compounds in question. Neither Rapkine's idea of protein as an —SS— reducing agent, nor Mazia's idea of the spindle as a glutathione-releasing agent can account for the behavior of the microscopes.

With respect to *function*, there are at least a few facts that point in the direction of a metabolic role for the glutathione. It has already been found in lily anthers that ascorbic acid concentration increases during microspore mitosis; by contrast, oxygen consumption falls (*7*, *8*). The twin occurrence of ascorbic acid and glutathione where the normal channels of terminal oxidation are interrupted may have some significance. Glutathione and ascorbic acid appear to play an important role in the respiration of embryonic plant tissues in which cell divisions are presumably frequent (*9*). In a number of animal tissues, ascorbic acid and glutathione have been found in isolated nuclei; possibly they are associated in some ways with nuclear metabolism (*8*). Thus, whether or not Rapkine was correct in picturing glutathione as effecting a fermentation in the cell to stimulate division, his idea that glutathione plays a metabolic role in the process of cell division certainly finds support in the behavior of lily microspores.

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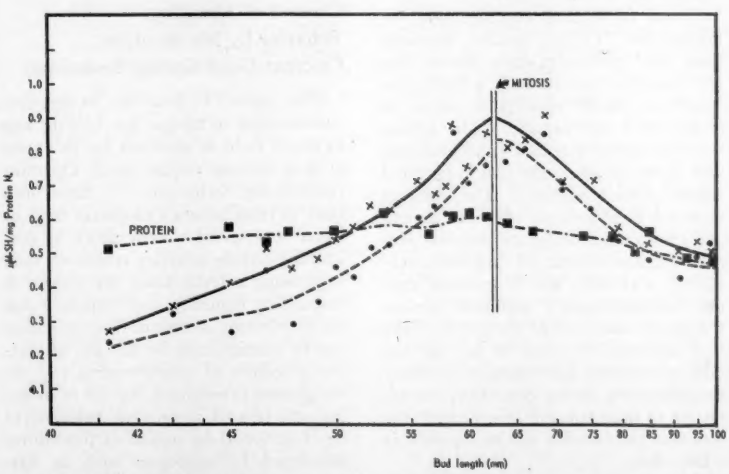

Fig. 1. Concentration of thiols in relation to nuclear division in *Lilium longiflorum*. Protein —SH (dots and dashes) was determined amperometrically in the presence of sodium lauryl sulfate after the protein had been washed twice with sulfosalicylic acid. The solid line represents total soluble thiols; the broken line, reduced soluble thiols. The use of bud length as an index of cell development has already been established (*7*).

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16 November 1956

Preparation and Properties of Growth Hormone from Human and Monkey Pituitary Glands

Following the isolation of growth hormone (somatotropin) in pure form from beef pituitaries (*1*), many attempts have been made to determine its effectiveness in man, but without success (*2*). Similarly, it has been shown that while growth hormone prepared from fish pituitaries is active in fish, it is not active in rats (*3*). Likewise, somatotropin concentrate from monkey pituitaries is active in the monkey, whereas the beef hormone is not (*4*). One of the obvious explanations for the failure of the beef somatotropin to act in man is that the beef somatotropin is chemically different from the hormone derived from man. We wish to report (*5*) that the human and monkey growth hormones are indeed different from the beef hormone.

From 0.8 g of lyophilized human pituitaries (*6*) extracted with CaO solution, an active concentrate was obtained by precipitation with 1.9*M* $(NH_4)_2SO_4$ as previously described (*7*). The $(NH_4)_2SO_4$ precipitate was extracted with phosphate buffer of *p*H 5.1, containing 0.057*M* Na^+ and 0.45 *M* $(NH_4)_2SO_4$. The clear extract was chromatographed on the polycarboxylic acid resin Amberlite IRC-50 (XE-97) under the conditions shown in Fig. 1. The contents of tubes 99 to 127 were combined, and the active component was precipitated by adding an equal volume of 5.0*M* $(NH_4)_2SO_4$. The precipitate was dissolved and dialyzed. The dialyzed solution was brought first to *p*H 4.5 and

Table 1. Bioassay by the tibia test of growth hormone isolated from human, monkey, and beef pituitary glands.

Total dose (μg)	Beef		Monkey		Human	
	Rats (No.)	Tibia width (μ)	Rats (No.)	Tibia width (μ)	Rats (No.)	Tibia width (μ)
20	9	217 ± 5*	12	225 ± 5	8	213 ± 2
60	8	246 ± 2	13	248 ± 3	8	235 ± 2
120	8	268 ± 8	14	276 ± 6	6	256 ± 2

* Mean ± standard error.

Table 2. Physicochemical characteristics of growth hormone isolated from human, monkey, and beef pituitary glands.

Physicochemical characteristics	Beef*	Monkey	Human
Sedimentation constant, $S_{20,w}$	3.19 *S*	1.88† *S*	2.47† *S*
Diffusion constant, $D_{20} \times 10^7$	7.23	7.20†	8.88†
Molecular weight	46,000	25,400	27,100
Electrophoretic mobility‡ (cm^2/sec/volt)	6.8×10^{-5}	5.1×10^{-5}	
Isoelectric point, *p*H	6.85	5.5	(5.5)‖

* Taken from C. H. Li (*13*).
† Carried out in *p*H 2.3 phosphate buffer of 0.2 ionic strength.
‡ Acetate buffer of *p*H 4.0 and ionic strength of 0.03 at 0.5°C.
‖ *p*H of minimal solubility in salt-free solution.

Table 3. Amino acid composition of growth hormone isolated from human, monkey, and beef pituitary glands (No. of residues per mole).

Amino acid	Beef*	Monkey	Human
Glutamic acid	50	33	36
Aspartic acid	35	26	31
Cystine	4	4	2
Serine	22	20	20
Threonine	26	13	14
Glycine	20	15	14
Alanine	31	11	14
Proline	14	10	12
Valine	14	9	10
Methionine	7	6	4
Leucines	76	41	38
Phenylalanine	27	16	14
Tyrosine	11	7	5
Lysine	23	12	12
Histidine	7	5	5
Arginine	26	13	14
Tryptophan	3	1	1
Total	396	241	245

* Taken from Li and Chung (*14*).

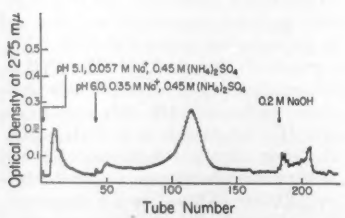

Fig. 1. Chromatography on the Na form of Amberlite XE-97 resin (dimension of column, 3 by 30 cm) of a growth hormone concentrate (100 mg) obtained from human pituitaries; 10 ml per tube. The hormonal activity is located in tubes 99 to 127.

then to *p*H 5.5; any precipitates formed at these two *p*H's were removed by centrifugation. The clear supernatant fluid was then diluted to a 0.2 percent solution; 40 percent ethanol (volume per volume) was added slowly at 0°C with vigorous stirring until the concentration of ethanol reached 5 percent by volume. The precipitate formed was removed by centrifugation and discarded; the supernatant was brought to 20 percent ethanol. The 5- to 20-percent ethanol precipitation was dissolved in a solution of *p*H 7 and lyophilized. The final product (*8, 9*) weighed 29 mg. By the same procedure, 20 mg of the somatotropin protein could be obtained from 1 g of lyophilized monkey pituitaries. These products, when assayed in hypophysectomized rats by the tibia test (*9*), were found to have growth-promoting activities comparable to that of the beef hormone, as shown in Table 1.

Both human and monkey somatotropin preparations have been submitted for purity studies employing electrophoresis and ultracentrifugation, as well as N-terminal amino acid analysis. These investigations indicate that both preparations possess a high degree of homogeneity. Certain physicochemical data may be seen in Table 2. Dinitrophenylation (*10*) of both human and monkey hormone protein yielded phenylalanine as the sole N-terminal residue. Amino acid analyses of human and monkey hormone preparations reveal that they are similar but that their compositions differ significantly from that of the beef hormone (see Table 3); tyrosine and tryptophan were estimated spectrophotometrically (*11*), and the other amino acids were estimated by quantitative paper chromatography of their dinitrophenyl derivatives (*12*).

It may be recalled that structural investigations (*13*) of growth hormone from beef pituitaries have shown that the hormone protein with a molecular weight of 46,000 appears to consist of a branched polypeptide chain having two N-terminal residues (phenylalanine and alanine) and only one C-terminal residue (phenylalanine). The findings reported here indicate that the human and monkey hormones are proteins with a molecular weight of approximately 26,000, with only one N-terminal residue (phenylalanine), and with isoelectric points more acidic than that of the beef hormone. Whether or not the human and monkey hormones, prepared by the procedure herein described, are effective in man is being investigated; the results of such studies will be reported at a later date.

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16 November 1956

Control of Drinking Behavior by Means of an Operant-Conditioning Technique

This paper (*1*) describes an operant-conditioning technique for forcing rats to ingest fluid in amounts far in excess of their normal requirements. Operant-conditioning techniques (*2*) have been used to train animals to obtain food or water or to avoid electric shock by performing certain arbitrary responses, such as pressing a lever. Once the animal is responding regularly, the frequency and the distribution in time of these responses can be manipulated by the use of various schedules of reinforcement (*3*). In the present experiment, the act of drinking was treated as operant behavior to be conditioned by means of procedures developed for responses such as bar-pressing. By controlling the frequency of the animal's drinking, the experimenter manipulates the amount ingested.

The rat is placed in a cage where intermittent shocks are delivered through

a grid floor. By licking the fluid at the end of a tube, the rat can postpone the next shock. The licks are detected by means of an electronic apparatus called a "drinkometer" (*4*): each time the rat's tongue touches the fluid, a thyratron tube operates the recording and programing apparatus.

We have found that drinking detected in this fashion can be reinforced successfully as operant behavior. Under a schedule of reinforcement, modified from one described by Sidman (*5*), we have succeeded in forcing ingestion of liquids that are normally refused, in producing ingestion of abnormally large quantities of water, and, using a liquid nutrient, in producing marked obesity in normal rats.

Careful selection and placement of the drinking tube are necessary to obtain these results. The tube is made of glass tubing 9 mm in diameter, flame-polished to an aperture of 3 mm at the lower end. The tube is mounted to form a 30° angle with the front of the cage, and an inverted 100-ml graduated cylinder, which serves as the fluid reservoir, is connected to the upper end. The lower tip of the tube is set 4 mm from a rectangular opening 5 mm wide by 9 mm high through which the rat licks. Restricting accessibility to the tube in this way insures that only the licking response is reinforced. Otherwise, alternative responses that operate the drinkometer (for example, pawing the tube or pressing it with the nose) may postpone the shock and tend to replace the drinking response.

Shock is provided by the output of a variable transformer connected to the grid floor. After each shock, the connections between the grid bars are automatically changed. This "grid-scrambling" was found necessary to prevent the rat from escaping shock by standing on bars continuously connected together. The duration of the shock pulse is 92 msec, and shocks are applied at 0.9 sec intervals if the rat does not respond.

Initial conditioning is best accomplished without strict limitation of the response. For this procedure, the drinking aperture resembles an inverted keyhole rather than a rectangle. The circular portion, 10 mm in diameter, allows the rat's jaw to protrude and brings the tongue nearer to the tube. During this phase of the training, the drinking tube is placed nearer to the aperture and filled with a 10-percent sucrose solution. Before being placed in the cage, the rats are deprived of water for 24 to 48 hours. Each lick postpones a 65-v shock for 5 sec. After a 12-hour period, the shock level is raised from 65 to 90 v.

A typical pattern of licking is generally observed when the shock level is raised: the rat licks once immediately after each shock, thereby postponing the next shock for 5 sec. Normally, in a situation where no shock avoidance is involved, rats drink in bursts of several hundred licks, and single licks rarely occur.

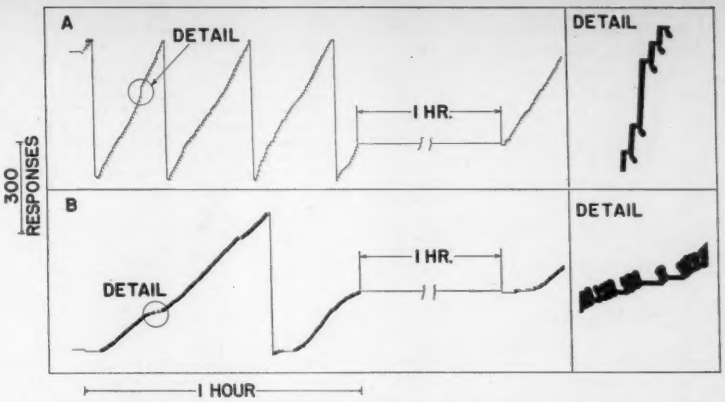

Fig. 1. Cumulative response records showing forced drinking during a typical 2-hr session. The pen moves upward with each lick and toward the right as time elapses. Each shock period is indicated by a small (⅛") downward displacement of the pen. (*A*) Drinking of a liquid nutrient showing several licks after each shock. (*B*) Drinking of a quinine solution showing single licks after each shock.

When experimental control of the licking response has been demonstrated in this manner, a schedule of reinforcement is selected that maintains drinking of appropriate quantities. Because single licks do not produce a large-volume intake, we developed a schedule that differentially reinforces several licks. The values of shock and the shock-postponement periods we chose are convenient for forcing the ingestion of a large quantity of liquid nutrient; other values may be appropriate for different liquids and when different durations of drinking are sought. Under our schedule of reinforcement, the rat can postpone shock for either a short period or a long one. The first lick following a shock postpones the next shock for 1 sec. Each successive lick results in the same postponement, unless three more licks are made within 7 sec of the first. In this case, the shock is postponed for 15 sec, and any lick within this 15-sec period, called the response-shock period, postpones the next shock for 15 additional sec.

Using these values, we were able to produce drinking of 10 ml per hour of a nutrient liquid (*6*) when drinking was reinforced on alternate hours for 24 hours each day. This procedure, continued for 20 days, resulted in the body weight's increasing from 240 to 406 g in a normal female rat. The average daily consumption of fluid in this period was 89 ml. When no shock is present, a normal female rat ingests about 48 ml daily and shows little or no gain in weight. Figure 1*A* shows a cumulative record of drinking during a 2-hour session. The short downward displacements indicate the onset of shock, and the recording pen remains in this displaced position until the next lick. It is readily seen that the occurrence of a shock is followed immediately by drinking sufficient to produce the longer postponement of shock. During the second hour, no shocks were presented. Likewise, no licking or drinking was observed. This typical result demonstrates effective control of drinking behavior.

If the shock sessions are carried out continuously for several hours, a change appears in the pattern of licking. The relative frequency of single licks increases until bursts of licking appear only rarely. We feel that this effect is due to the increasing aversion to drinking as the capacity of the stomach is approached.

Figure 1*B* was obtained with the same schedule of reinforcement, but with an aversive quinine solution substituted for the liquid nutrient. During a 24-hour period, the rats normally refused to drink the quinine solution ($3.4 \times 10^{-4} M$). During the period of forced drinking, the rat licked immediately each time the shock came on but never enough to produce the longer postponement period. The record for the next hour shows that no drinking occurred when shocks were not presented.

When water, rather than quinine or liquid nutrient, was placed in the drinking tube, six normal satiated animals drank approximately 30 ml in 5 consecutive hours under the same schedule of reinforcement.

The technique here described has been applied successfully to the problem of producing obesity in normal animals

by manipulating both the daily pattern of ingestion and the volume ingested. The technique appears useful when it is desirable to control fluid ingestion in normal satiated rats.

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References and Notes

1. This paper reports research supported in part by a grant from the National Science Foundation. We wish to thank William H. Morse of the Harvard University department of psychology for his advice and generosity in allowing the use of several pieces of control equipment.
2. B. F. Skinner, *The Behavior of Organisms* (Appleton-Century, New York, 1938).
3. C. B. Ferster and B. F. Skinner, *Schedules of Reinforcement* (Appleton-Century-Crofts, New York, in press).
4. E. Stellar and J. H. Hill, *J. Comp. Physiol. Psychol.* **45**, 96 (1952).
5. M. Sidman, *ibid.* **46**, 253 (1953).
6. The liquid diet is composed of 250 ml of evaporated milk, 125 ml of 50-percent sucrose solution, 150 ml of whole egg, 30 ml of Kaopectate, and 0.3 ml of Multi-Vi Drops (White Laboratories, Inc., Kenilworth, N.J.).

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24 September 1956

Book Reviews

Statistical Mechanics, Principles and Selected Applications. Terrell L. Hill. McGraw-Hill, New York, 1956. 432 pp. Illus. $9.

It is always a very pleasant occasion when somebody who has made significant contributions to a field of physics can be persuaded to write a monograph on his field of interest, and the present monograph is no exception to the rule that usually such a monograph provides a welcome addition to the literature on the subject in question. The author discusses relatively briefly in the first three chapters the principles of statistical mechanics and the relation between statistical mechanics and thermodynamics. The fourth chapter deals with fluctuations. The fifth chapter treats the theory of imperfect gases and condensation, following largely Mayer's theory but giving also some new, alternative, derivations and discussing in the final section Yang and Lee's theory. The sixth chapter is devoted to a discussion of distribution functions and the liquid state. Chapter 7 deals with nearest neighbor lattice statistics, while the last chapter discusses lattice theories of the liquid and solid states. In a number of appendixes, the author gives some mathematical details. There is an adequate index at the back.

Although the author states that he hopes this monograph may be useful as a textbook for either an advanced course in statistical mechanics or as a supplement to a textbook such as Rushbrooke's in a more elementary course, I feel that the discussion is too technical for use as a textbook and that the main users of this monograph will be people working in the field who want to check up on the various methods that have been used in solving the problems discussed. For this purpose the monograph is an excellent one, and the discussion is very thorough.

I have a few minor criticisms, as one is always bound to have with any book. The reference to μ-space on page 92 is not really general in that it only refers to particles without internal degrees of freedom. The discussion of the third law of thermodynamics in section 14 is, to my mind, inadequate and does not pay sufficient attention to the clarification of the role of the third law which was given by Simon. Finally, I cannot feel that any useful purpose has been served by giving in 15 pages a bird's-eye view of quantum mechanics. Those readers who are familiar with quantum mechanics will know all that is contained in this section, but those who do not know sufficient quantum mechanics to use this monograph with any profit would certainly not be able to learn sufficient quantum mechanics from such a brief exposé. However, I would like to emphasize once again that these criticisms are only minor ones and that the over-all picture given by this book is a very pleasant one.

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Fundamental Concepts of Higher Algebra. A. Adrian Albert. University of Chicago Press, Chicago, Ill., 1956. 165 pp. $6.50.

For the greater part of his new book, A. A. Albert reworks the same ground treated in the first nine chapters of his *Modern Higher Algebra,* written nearly 20 years earlier. However, in the present volume his presentation leads up to a discussion of finite fields, whereas the former volume closed with an account of p-adic number fields.

The first chapter presents the elementary theory of finite groups; the second discusses rings, fields, and some basic concepts of ideals; and the third covers vector spaces and matrices. Chapter IV is devoted to finite algebraic extensions of a field and to Galois theory in the modern treatment. The fifth and final chapter applies the methods of the previous chapter in a systematic study of the irreducible polynomials over a finite field. A concluding section of Chapter V lists about 20 theorems of L. E. Dickson on finite fields, without giving proofs.

Although most of the book reviews the fundamentals of modern algebra, there is more here than a simple repetition of old material. The selection and arrangement are expertly done, and new proofs are produced for a number of theorems to improve the unity and logical structure of the presentation.

Unfortunately, the virtues of the book are likely to be appreciated only by the specialist. Albert's style at its softest makes few concessions to the reader, and in this case, as the author notes in his preface, "the presentation is extremely compact, and requires slow and careful classroom discussion," if it is to be used as a textbook for a first course in modern alegbra. A rather liberal sprinkling of typographic errors will add to the student's troubles.

A single example will show how compact the discussion is. The proof of Fermat's theorem (that when p is prime and does not divide a, $a^{p-1}-$ is divisible by p) consists of the observation that the nonzero residue classes modulo p form a group of order p-1 under multiplication, together with a reference to the theorem that the order of a group is divisible by the order of any subgroup. Few authors would consider it superfluous to suggest at least that the subgroup to use is the one consisting of the powers of the residue class containing a.

It is too bad that the difficulties of style will limit the number of readers who might otherwise appreciate the brilliant qualities of this book. Mathematics could use more writers like G. H. Hardy.

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Antarctica in the International Geophysical Year. Based on a symposium on the Antarctic. Cosponsored by U.S. National Committee for the IGY; National Science Foundation; American Geophysical Union. Geophysical Monograph No. 1. American Geophysical Union, Washington, 1956. 133 pp. Illus. $6.

The American Geophysical Union and the U.S. National Committee for the International Geophysical Year are to be congratulated for the production of this excellent geophysical monograph. Although it is directed at Antarctic geophysical problems, several chapters have additional interest for other regions, particularly the Arctic.

The enormous impetus of the International Geophysical Year on geophysics, coupled with the remarkable advances in techniques of measurement since the Second International Polar Year, has made necessary a wide distribution of expert surveys of the problems in the many branches of geophysics.

The history of exploration on Antarctica, condensed into three pages, is a welcome introduction to, and serves also to emphasize the large scale of, this imminent assault on the still little-known continent.

It is pleasant to note a reference to the earliest experiments on the ionosphere in the Antarctic by the late Captain Malcohm P. Hanson, USN. These were made in 1929 and not in 1928. It might surprise present-day ionospheric experts, raised in the electronic age, to know that Captain Hanson obtained measurements of the height of the E-layer using a hand-operated mechanical oscillograph.

Photographs of the delay time of reflection of a fixed radio frequency from the E-layer were obtained. These I was privileged to see and discuss with Captain Hanson at the time. It appeared that there existed several very distinct ionospheric layers, but in later years it was realized that these records represented successive reflections from what must have been fairly intense sporadic ionization in the E-layer. At the time the major features of the structure of the ionosphere were not understood and sporadic-E was not known.

Reference is made in the chapter on cosmic rays to a recent rapid survey of cosmic-ray variation at sea level. Part of the survey was made with equipment from the cosmic-ray laboratory at Ottawa. This was taken on a circuit of North America on the Canadian icebreaker HMCS *Labrador* and subsequently, on the icebreaker USS *Atka*, on a circuit of South America and part of the Antarctic. This was a nice bit of international cooperation to which some spice is added by the fact that the cosmic-ray expert who sailed on both ships is a young Tasmanian.

The close relationship of problems in geomagnetism, the ionosphere, the aurora, and cosmic rays is emphasized strongly. It is not possible to solve all the problems of any single one of these interrelated branches of geophysics by the techniques of that branch alone. This has been recognized in the monograph in grouping these subjects together under the title of "Upper atmospheric physics."

There are two omissions in references, both suggested by my colleagues, to which attention might be drawn. These are the important paper in glaciology on the "Morphology and regime of the Maudheim Ice Shelf" by C. W. M. Swithinbank (*Geographic Journal* **121**, pt. I), and R. M. Laws' recent work on seals of the Antarctic.

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Topics in Number Theory. vols. 1 and 2. William J. LeVeque. Addison-Wesley, Reading, Mass., 1956. 198 pp.; 270 pp. Illus. $5.50; $6.50.

The first volume of this book is an excellently organized introduction to the elementary theory of numbers. After a proof of the unique decomposition theorem and a short treatment of linear diophantine equations, the author starts with the elementary theory of congruences. The usual topics such as linear congruences, the Chinese remainder theorem, congruences of higher degree, the theorems of Euler, Fermat, and Wilson, theory of primitive roots and indices are presented. This section culminates in a proof of the quadratic residue law and terminates with a discussion of the Jacobi symbol.

The next section of the book deals with the distribution of primes. The author decided to give the proof along classical lines, and the proof of the prime number theorem is therefore postponed to the second volume, and only the order of magnitude of $\pi(x)$ is obtained in the first volume. The tools acquired in order to establish the order of magnitude of $\pi(x)$ are then used to prove the Bertrand postulate, and the zeta function is introduced to derive asymptotic expressions for the average values of the functions ϕ, τ, and σ. The author entitles this section "average order of magnitude" but derives more than just the order of magnitude. Then follows a short but adequate section on the representation of integers by sums of squares and a discussion of Pell's equation. A final section is devoted to the approximation of real numbers by rational numbers.

The first half of the second volume might still be regarded as a continuation of the first volume and begins with the theory of binary quadratic forms. This is followed by a short introduction to the theory of algebraic numbers. The unique decomposition theorem is established as well as the fact that the group of units is finitely generated. The author does not choose to compute the number of independent generators, however. There follows a discussion of cyclotomic fields with main emphasis on the units. The laws of factorization of rational primes in cyclotomic fields are not discussed. As an application the author gives a proof of Fermat's conjecture for regular primes in the "easier" case and quotes Kummers Lemma to give an exposition of the proof for the "harder" case.

This section of the book is too scanty. Apart from its general interest a somewhat more extensive treatment of the theory of algebraic numbers would have paid off in Chapter 6, where the author proves the Dirichlet theorem on arithmetic progressions.

The second part of the second volume presents a selection of topics in analytic number theory. It starts with an excellent and very readable account of the Thue, Siegel, Roth theorem with various applications. A chapter on transcendental numbers follows with a proof of Lindemann's theorem and culminates in the proof of the theorem of Gelfond and Schneider. Chapter 6 has already been mentioned, and in Chapter 7 a proof of the prime number theorem and its extension to arithmetic progressions is given along classical lines.

The first part of the book is eminently suitable for a graduate or advanced undergraduate course in the theory of numbers. It is also equally well suited to introduce a reader with an adequate background to the subject. The second volume gives a stimulating selection of more advanced topics with an unmistakable preference for analytic, rather than algebraic and combinatorial, methods.

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Begegnungen mit dem Vormenschen. G. H. R. von Koenigswald. Eugen Diederichs, Düsseldorf/Köln, 1955. 230 pp. Illus. + plates. DM. 13.80.

The author of this book, well known for his brilliant discoveries of the pithecanthropoids at Modjokerto and Sangiran in Java, as well as the enigmatic teeth of *Gigantopithecus* from South China, has visited many of the Old World localities that have yielded remains of fossil man. Here he treats

mainly of the circumstances under which many of these finds were brought to light and recounts various little-known anecdotes bearing on the actual discoverers. Essentially this well-illustrated little book is intended for the public, but the very amusing and carefully selected sidelights that are included will also be of great interest to paleoanthropologists.

In six well-organized chapters, G. H. R. von Koenigswald describes the original investigations at Trinil in Java, Choukoutien in China, and his own finds of the *Gigantopithecus* teeth among the collections of "dragon bones" in Chinese drugstores in Hong Kong and Canton. This is followed by a very revealing account of the discoveries in Java of no less than 11 fossil human skulls at Ngandong in the Solo Valley, the Modjokerto child, and the impressive remains of *Pithecanthropus* and *Meganthropus* from Sangiran; in Africa L. S. B. Leakey's finds of *Proconsul* on Rusinga Island in Lake Victoria, at Oldoway in Tanganyika and Olorgesailie in Kenya are discussed, as well as the australopithecine material from the Transvaal.

Next there is a résumé of the Piltdown forgery, a brief interpretation of the Upper Paleolithic paintings in the Cave of Lascaux in southern France (the only subject included in the text that does not directly bear either on the problem of early human evolution or the development of Lower Paleolithic culture), and finally a short treatise covering certain aspects of the phylogeny of the Hominoidea in which the author outlines certain of his views on human evolution.

In addition to the known facts pertaining to each discovery, the text includes a wealth of background data, very little of which has previously been published. Thus from the point of view of the paleoanthropologist, the greatest merit of this small volume lies in the fact that an outstanding expert in the field has made this material available to his colleagues. It is to be hoped that an English edition of this exceedingly well illustrated book can be published in the not-too-distant future.

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Experimental Stress Analysis in the U.S.A. and Canada. Overseas Technical Reports No. 1. Department of Scientific and Industrial Research. H.M. Stationery Office, London, 1956 (order from British Information Services, 30 Rockefeller Plaza, New York 20). 22 pp. $0.36.

There are at present British scientific attachés in Washington, Paris, Stockholm, and Bonn. There has hitherto been no convenient means of publishing some of the material they assemble. A new series of official reports entitled Overseas Technical Reports has now been introduced to fill this need. The first of these was written by A. F. C. Brown, of the British National Physical Laboratory, while he was attached to the Scientific Mission in Washington, D.C., in 1954 and 1955.

The report, with a bibliography of 107 items, is based largely on the literature published in the period but is supplemented by information collected during discussions and visits at various establishments.

High Energy Nuclear Physics, Proceedings of the Sixth Annual Rochester Conference 3–7 Apr. 1956. J. Ballam, V. L. Fitch, T. Fulton, K. Huang, R. R. Rau, and S. B. Treiman, Eds. Interscience, New York, 1956. 9 sections, $3.75.

This book is a report, essentially verbatim, of the formal sessions of the conference, with the addition of a few appendixes containing material that was not presented at the meetings, because of insufficient time.

This conference was attended by almost 200 physicists, including more than 30 from foreign countries, of which three were from the U.S.S.R. It therefore represented almost all the laboratories where research in high-energy nuclear physics is in progress; and this report, then, contains most of the progress in this field during the past year.

Because of the rapid progress in high-energy physics, it is necessary that material of this sort be published with a minimum of delay in order not to be out of date. For this reason, one must excuse the paper covers, the type of printing, a photo-offset process from ordinary typewriter type, and the figures, which were all reproduced from slides shown at the meeting. Rather, the editors should be congratulated for the lack of typographic errors in the text and their very accurate reporting. The type is clear and easy to read, and almost all of the figures are very well reproduced. The informal nature of the discussions is well reproduced.

The organization of the book is that of the conference itself, in which each half-day session was on a different topic. These are as follows: classical pion physics; nucleon-nucleon scattering below 500 Mev; theoretical session; pion-nucleon and nucleon-nucleon interactions above 500 Mev; properties of heavy mesons and hyperons; production and interaction of heavy mesons and hyperons; antinucleons; theoretical interpretation of new particles; mesonic atoms, electron-nucleon and photon-nucleon scattering, and miscellaneous topics.

In each session, an introductory survey of recent work of around ten pages is given by a leading authority. After this there follows a series of shorter papers, from a few lines to several pages in length. After each paper there was opportunity for discussion, which is also recorded. The book also contains a foreword by R. E. Marshak, a fairly complete table of contents, and, at the end, a list of conference participants. For obvious reasons, it does not contain cross references or bibliography. For these reasons, and also because of the lack of introductory material, it is not recommended as a beginning textbook for a novice in high-energy physics. However, for those working in the field, this is an important part of their library and is extremely useful.

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New Books

English Translation of the Bulletin of the Academy of Sciences of the USSR. Physical Series. vol. 19, No. 5. Columbia Technical Translations, White Plains, N.Y., 1956. 109 pp. $20.

Descriptive Geometry. College Outline Series. Steve M. Slaby. Barnes & Noble, New York, 1956. 353 pp. $2.25.

Biological Sciences. Series VI. *Progress in Nuclear Energy.* J. C. Bugher, J. Coursaget, J. F. Loutit. McGraw-Hill, New York; Pergamon, London, 1956. 205 pp. $7.

Trigonometry Refresher for Technical Men. A. Albert Klaf. Dover, New York, 1956 (unaltered republication of ed. 1). 629 pp. Paper, $1.95.

Calculus Refresher for Technical Men. A. Albert Klaf. Dover, New York, 1956 (unabridged republication of ed. 1). 431 pp. Paper, $1.95.

Physiologie de l'Insecte. Le comportement, les grandes fonctions, ecophysiologie. Rémy Chauvin. Institut National de la Recherche Agronomique, Paris, ed. 2, 1956. 917 pp. $9.50.

The Chemistry and Technology of Leather. vol. I, *Preparation for Tannage.* Fred O'Flaherty, William T. Roddy, Robert M. Lollar. Reinhold, New York; Chapman & Hall, London, 1956. 495 pp.

General Genetics. M. J. Sirks. Translated by Jan Weijer and D. Weijer-Tolmie. Nijhoff, The Hague, 1956. 628 pp. G. 35.

Jews in the World of Science. A biographical dictionary of Jews eminent in the natural and social sciences. Harry Cohen and Itzhak J. Carmin. Monde, New York, 1956. 264 pp.

Cellular Mechanisms in Differentiation and Growth. Fourteenth Symposium of the Society for the Study of Development and Growth. Dorothea Rudnick, Ed. Princeton University Press, Princeton, N.J., 1956. 236 pp. $7.50.

Meetings and Societies

International Society of Bioclimatology and Biometeorology

A new organization—the International Society of Bioclimatology and Biometeorology—was created in Paris, France, during the period 29–31 Aug. 1956. Some 60 scientists from 15 nations (Austria, Canada, France, French West Africa, Germany, Great Britain, Israel, Italy, Japan, the Netherlands, Norway, Spain, Switzerland, Turkey, and United States) who represented a wide range of biological, medical, and meteorological interests attended the 3-day administrative and scientific sessions held in UNESCO House. S. W. Tromp, of Leiden, the Netherlands, was primarily responsible for bringing to fruition the long-nurtured idea of an international society in the area, and he almost singlehandedly organized this first meeting. Strong support was received from the membership, which numbers about 325, from UNESCO and from the World Meteorological Organization.

The executive board of the society consists of the following: president, F. Sargent II (physiologist, United States); vice presidents, E. Boyko (botanist, Israel), H. Berg (meteorologist, Germany), and L. Emberger (botanist, France); advisory members, W. E. Arnould-Taylor (biologist, Great Britain) and W. G. Wellington (entomologist, Canada); secretary-treasurer, S. W. Tromp, (geophysicist, the Netherlands).

A governing council of 20 members, one from each country represented in the total membership, was appointed (K. Buettner is the United States representative). Several administrative matters were unanimously approved: the statutes of the society, a membership committee, and formation of study committees covering special areas of bioclimatology and biometeorology. Four such study committees were initiated: committee on allergy, R. Alemany-Vall (Spain), chairman; committee on ecological climatography, E. Boyko (Israel), chairman; committee on ionization of the air, J. H. Kornbleuh (United States), chairman; and committee on instrumentation and methods, J. D. Griffiths (Great Britain), chairman. There was discussion of a proposal to form a committee on nautical bioclimatology.

Plans were made to create an international clearinghouse for bioclimatology and biometeorology. The headquarters will be at the address of the secretary-treasurer of the society (S. W. Tromp, Hofbrouckerlaan 54, Oegstgeest (Leiden), Netherlands. The aims of the clearinghouse are (i) to facilitate exchange of information, progress reports on research, and bibliographic material (reprints and photocopies of publications) among persons interested in bioclimatology and biometeorology and (ii) to prepare bibliographies of current publications and of special areas of bioclimatology and biometeorology. The latter would be published in a technical journal of the society.

It was voted that the executive board should explore the possibilities of creating a journal. The contents of the journal would consist of transactions of meetings, bibliographic information on literature on bioclimatology and biometeorology, short articles and notes on research in progress, queries for information, periodic critical reviews of special areas of bioclimatology and biometeorology, and reports of committees of the society.

A definition and description of bioclimatology and biometeorology were unanimously adopted: "Bioclimatology and biometeorology comprise the study of the direct and indirect interrelations between the geophysical and geochemical environment and living organisms, plants, animals, and man.

"The term *environment* is broadly conceived and includes micro-, macro-, and cosmic environments and the diverse physical and chemical factors which comprise these environments.

"Investigations in these disciplines are conducted in nature and in the laboratory under as rigidly controlled conditions as possible to describe measurable and reproducible physical, chemical, and biological factors which show a sufficiently high statistical correlation with measurable physiological and pathological processes to suggest a valid cause and effect relationship between organism and environment."

Finally, the membership resolved to cooperate with international and national organizations in allied fields, to support existing abstracting services, and to hold international scientific congresses.

Areal reports were given on the nature and scope of research and training in bioclimatology and biometeorology in various regions: Egypt, France, Israel, and Spain, by L. Emberger; French West Africa, by J. P. Nicholas; the Americas (except Canada), by D. H. K. Lee; Southeast Asia, by E. M. Glaser; Canada, by W. G. Wellington; Great Britain, Uganda, Kenya, and South Africa, by J. L. Cloudsley-Thompson; and northwestern Europe (except France and Great Britain), by K. Knoch and S. W. Tromp.

The reports were discussed by the members. Special invited papers were read: "Biologische Einflüsse von Elektro-Aerosolen," by H. Cauer; "Die biologische Wirkung negativ und positiv geladener Aerosole und der direkten negativen and positiven Aufladung des menschlichen Organismus," by K. H. Schulz; "Nautical bioclimatology," by Guido d'Avanzo and L. M. Carles; "Possible cosmic effects in bioclimatology," by G. Piccardi; and "Ionic research in bioclimatology," by W. W. Hicks and J. D. Beckett. Short informal papers were presented by K. Buettner on water reabsorption by soil and skin, D. H. K. Lee on a physiological index of climatic stress, and J. Pichotka on weather and coagulation of blood.

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Microbiology in Mexico

The Primer Congreso Nacional de Microbiología, sponsored by the Asociación Mexicana de Microbiología, was held in Mexico City, 17–20 Oct. 1956. This first attempt of the association to conduct a meeting of this magnitude was a complete success and reflects the interest in microbiology to be found in Mexico. The organizing committee included Carlos del Río Estrada, president of the association, and Adolfo Pérez Miravete, coordinating president of the congress.

There were 273 registrants, representing 13 cities in Mexico and five foreign countries. Among the foreign visitors were Guillermo Muñoz Rivas of Bogota and the following from the United

States: Geoffrey Rake, Carlos España and Mrs. España, Joseph L. Rabinovich, and Francis B. Gordon who acted as official representative of the Society of American Bacteriologists.

The scientific sessions, which took place at the Instituto de Salubridad y Enfermedades Tropicales, were inaugurated by Ignacio Morones Prieto, Secretary of Public Health and Welfare of the Republic of Mexico. Of the 86 papers presented, 36 dealt with medical bacteriology and related subjects, 20 with general, industrial, or agricultural bacteriology, 14 with virology, 13 with parasitology, and 3 with mycology.

High points of the program were the three symposia on poliomyelitis, malaria, and antibiotics, respectively. The first described work on poliomyelitis being conducted at two different laboratories in Mexico, including data on manufacture of the vaccine. During the second symposium, Marques Escobedo, office of the Secretary of Public Health and Welfare, described the campaign in Mexico for the eradication of malaria. Discussion of various aspects of antibiotics as related to human medicine and to control of plant diseases made up the third symposium.

At the closing session of the congress several announcements of general interest to microbiologists were made: (i) A Type Culture Collection has been created, to be maintained under the sponsorship of the Asociación Mexicana de Microbiología. (ii) An Asociación Latinoamericana de Microbiología has been formed, consisting of representatives of 14 countries of Central and South America. Among its future activities will be joint sponsorship, with the Mexican Association, of a second Congress of Microbiology in Mexico City at an appropriate date. (iii) The need for a Latin American journal of microbiology was discussed. Its future development was left in the hands of the Mexican Association.

FRANCIS B. GORDON
Naval Medical Research Institute, Bethesda, Maryland

Comparative Biology of Marine Species

Between 27 June and 4 July 1956, 44 invited participants and 27 observers representing 14 nations met at the Biological Station of the University of Paris in Roscoff, France, for the purpose of an international marine colloquium. The subject was "The comparative biology of marine species in different districts of their area of distribution."

The meetings were sponsored by IUBS (International Union of Biological Sciences) under the general chairmanship of S. Horstadius (Sweden), but the detailed arrangements and conduct of the colloquium were under the direction of Pierre Drash, associate director of the Roscoff Station and professor of zoology at the University of Paris. The participants were the guests of the University of Paris for the duration of the conference. American participants were R. Buchsbaum (Pittsburgh), T. H. Bullock (California), A. Buzzati-Traverso (Scripps), R. W. Hiatt (Hawaii), C. L. Prosser (Illinois), B. T. Scheer (Oregon), and R. I. Smith (California).

The papers were delivered in English or French, and simultaneous translation was available in the alternate language through earphones. Papers presented were on the reproduction of the oyster on the coasts of Europe (P. Korringa, Holland); life-history of *Calanus* (a copepod) in different latitudes (A. P. Orr, England); growth and reproduction of marine algae in different regions (T. Levring, Sweden, and J. Feldman, France); meristic characters in fishes in relation to temperature and water movements (Scheer); paleoecological factors in the sea (Buchsbaum); combined influence of temperature and salinity (J. Verwey, Holland); lethal temperature as a tool for the taxonomist (F. E. J. Fry, Canada); inshore temperatures (H. Barnes, Scotland); physiological variation (Prosser); plankton (W. Harder, Germany); population differences in temperature adaptation (Bullock); genetic variation in relation to morphological variation in a snail, *Purpura* (H. R. Staiger, Switzerland); sexual variation (G. Bacci, Italy); tolerance of low salinities by nereids and its relation to temperature and reproduction (Smith); comparative biology of nereids (M. Durchon, France); comparative biology of crabs, Carcinides, in the Mediterranean (A. Veillet, France); sexual cycles of *Mytilus* sp. (P. Lubet, France); suggestions for the determination of biological cycles (Drash); length of the intestine of fishes and latitude (Harder); hydrozoans (B. Swedmark, Sweden); a program of study of comparative biology of marine species (O. Kinne, Germany); *Artemia* and *Mytilus* in the North Sea and in the Baltic (C. Schlieper, Germany); comparative ecology of Idotea (G. Petit, France); genetic research on different races of Tigriopus (Br. Bozic, Yugoslavia); biometric studies on different races (G. Teissier, France).

In addition to their papers, the participants discussed various ways of facilitating international cooperation in research and exchange of information and adopted the following resolutions:

"The International Conference on Comparative Marine Biology sponsored by the IUBS, attended by scientists of fourteen nations, and held June 27 to July 4, 1956, at the Biological Station of Roscoff, having had this outstanding opportunity of surveying the present status of comparative marine biology requests that IUBS, ICSU, UNESCO, and FAO focus their attention on, and stimulate the action of, national agencies towards the support and extension of basic research in marine biology. Human societies have reached a stage at which their progress depends upon the acquisition of knowledge at a fundamental level. Current progress in marine biology is slow and lags behind that in many other sciences; concerted effort should be made to remedy this situation. Great diversity of biological phenomena exist in the sea whose study is essential to an understanding of basic biological processes. Only as the problems are attacked will the vast marine resources of economic importance be successfully exploited.

"It appears necessary at this moment to: (i) Increase the number of permanent positions in the sciences converging on marine biology; (ii) provide for technical personnel to permit the establishment of a world-wide program designed to obtain continuous records of basic information of a physical, chemical, and biological nature, fundamental to marine biology; (iii) take steps to further collaboration with existing bodies devoted to marine science, *e.g.*, ISC, UGGI, CPEM, and so forth; (iv) further international cooperation by supporting fellowships, travel, meetings, and an international information service; (v) establish a committee to further these resolutions and to represent the interests revealed in this conference.

"The elucidation of the factors affecting the distribution of marine animals can only be accomplished by general biological, physiological, and genetical studies of species. Cooperation on a wide scale is essential.

"This conference has revealed numerous and important gaps in our knowledge within this field of comparative biology; these could be filled by cooperative international effort. The conference has shown that there is much international goodwill directed towards this end; the following suggestions are made to encourage progress in this direction: (i) Investigations of the biology of species throughout their geographical range. We recommend programs of the following nature, leading to a synthesis of evolutionary, physiological and ecological marine biology: (*a*) morphometric characters of marine animals and plants; (*b*) life cycles and their adjustment to periodic and other environmental variations; (*c*) species replacement and community structure; (*d*) physiological responses and tolerances to stresses imposed by varying temperature, salinity, nutritive factors, and so forth; (*e*) the flux of matter and energy through organisms and communities, the resulting balance

sheets and the internal mechanisms involved; (*f*) the genetical background of variation and the effects of selection on some experimental populations. (ii) The collection of basic information. We recommend that institutes should be encouraged to set up programs designed to obtain continuous records of those variables required by many studies: a mechanism for outstanding techniques and distributing the results should be established. The information required is of a physical, chemical, and biological nature. While realizing that the amount of information that it will be possible for any given institute to collect under any of these headings must necessarily vary with the facilities and personnel, we would particularly draw attention to the following: (*a*) temperature, salinity, *p*H, oxygen content, nutrient elements, organic matter, plant pigments, light intensity, and transparency. These should be measured regularly; (*b*) faunistic and floristic lists should be published; every effort should be made to have available at least a list of the common species of a given region and if possible information on breeding seasons and abundance."

RALPH BUCHSBAUM
Department of Biological Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania

Society Elections

■ American Medical Writers' Association: pres., Dean F. Smiley, Chicago, Ill.; pres.-elect, Charles E. Lyght, Merck Sharp and Dohme, Rahway, N.J.; 1st v. pres., Morris Fishbein, Chicago, Ill.; 2nd v. pres., Theo R. Van Dellen, Chicago, Ill.; sec.-treas., Harold Swanbert, 510 Maine St., Quincy, Ill.

■ American College of Dentists: pres., Gerald D. Timmons, Temple University School of Dentistry; pres.-elect, Alfred C. Young; v. pres., Thomas J. Hill; sec., Otto W. Brandhorst, 4221 Lindell Boulevard, St. Louis 8; treas., William N. Hodgkin.

■ Tennessee Academy of Science: pres., Isabel H. Tipton, University of Tennessee; pres.-elect, Arlo I. Smith, Southwestern at Memphis; sec., Donald Caplenor, George Peabody College for Teachers, Nashville; treas., Harris J. Dark, David Lipscomb College. Representative to the AAAS Council is Clinton L. Baker.

■ Association of Military Surgeons: pres., Col. Amos R. Koontz. The vice presidents are Col. Charles R. Mueller, Brig. Gen. H. H. Twitchell, Maj. Gen. Wallace H. Graham, Ass't. Surg. Gen. John W. Cronin, Maj. Gen. James P. Cooney, and Rear Adm. Irwin L. V. Norman.

Forthcoming Events

January

14–16. Cottonseed Processing as Related to the Nutritive Value of the Meal, 4th conf., New Orleans, La. (Southern Regional Research Lab., USDA 1100 Robert E. Lee Blvd., New Orleans 19.)

14–16. Reliability and Quality Control in Electronics, 3rd natl. symp., Washington, D.C. (C. M. Ryerson, Radio Corp. of America, Bldg., 10–6, Camden 2, N.J.)

14–18. Society of Automotive Engineers, annual. Detroit, Mich. (Meetings Div., SAE, 29 W. 39 St., New York 18.)

14–20. Indian Science Cong. Assoc., 44th meeting, Calcutta, India. (General Secretary, ISCA, 1 Park St., Calcutta 16.)

15. Society for Applied Spectroscopy, Philadelphia, Pa. (F. M. Biffen, Johns-Manville Research Center, Manville, N.J.)

16–23. Australian and New Zealand Assoc. for the Advancement of Science, 32nd meeting, Dunedin, N.Z. (J. R. A. McMillan, ANZAAS, Science House, 157 Gloucester St., Sydney, N.S.W., Australia.)

17. Constructive Medicine in Aging: Cardiovascular Disorders in the Aged, symp., Cincinnati, Ohio. (J. B. Chewning, Wm. S. Merrell Co., Cincinnati 15.)

17–18. Engineers Joint Council, New York, N.Y. (EJC, 29 W. 39 St., New York 18.)

18–19. Symposium on Blood, 6th annual, Detroit, Mich. (W. H. Seegers, Wayne State Univ. Coll. of Medicine, Detroit 7.)

21–22. Solar Furnace Design and Operation, Phoenix, Ariz. (J. I. Yellott, Assoc. for Applied Solar Energy, 3424 N. Central Ave., Phoenix.)

21–25. American Inst. of Electrical Engineers, winter general, New York, N.Y. (N. S. Hibshman, AIEE, 39 W. 39 St., New York 18.)

23–25. Very Low Frequency Electromagnetic Waves, symp., Boulder, Colo. (J. R. Wait, National Bureau of Standards Boulder.)

24–25. Western Spectroscopy Assoc. 4th annual, Los Angeles, Calif. (S. S. Ballard, Scripps Inst. of Oceanography, San Diego 52, Calif.)

25. Bibliographical Soc. of America, New York, N.Y. (H. W. Liebert, Yale Univ. Library, New Haven, Conn.)

25–26. Protein Metabolism, 13th annual conf., New Brunswick, N.J. (W. H. Cole, Rutgers Univ., New Brunswick, N.J.)

28–29. Many Body Problem, symp., Hoboken, N.J. (G. J. Yevick, Dept. of Physics, Stevens Inst. of Technology, Hoboken.)

28–31. American Meteorological Soc., New York, N.Y. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

28–31. Modern Methods of Analytical Chemistry, 10th annual symp., Baton Rouge, La. (P. W. West, Louisiana State University, Baton Rouge.)

30–1. American Assoc. of Physics Teachers, New York, N.Y. (F. Verbrugge, Carleton College, Northfield, Minn.)

30–2. American Physical Soc., annual, New York, N.Y. (K. K. Darrow, APS, Columbia Univ., New York 27.)

30–31. College-Industry Conf., 9th annual, American Soc. for Engineering Education, Los Angeles, Calif. (Univ. of California Extension, Engineering, Los Angeles 24.)

31–1. Digital Computing in the Aircraft Industry, NYU–IBM symposium, New York, N.Y. (M. Woodbury, New York Univ., Research Div., 401 W. 205 St., New York, N.Y.)

31–2. Western Soc. for Clinical Research, 10th annual, Carmel-by-the-Sea, Calif. (A. J. Seeman, WSCR, Univ. of Oregon Medical School, Portland 1.)

February

3. American Assoc. of Bioanalysts, 3rd annual Margaret Beattie Lecture, San Francisco, Calif. (W. N. Reich, Walnut Creek-Lafayette, Laboratories, 1625 Locust St., Walnut Creek, Calif.)

4–8. American Soc. for Testing Materials, Philadelphia, Pa. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)

10–12. Canadian Ceramic Soc., 55th annual, Niagara Falls, Ont., Canada. (L. C. Keith, 49 Turner Road, Toronto, Ont.)

14. Present Status of Heart Sound Production and Recording, symp., Buffalo, N.Y. (R. M. Kohn, Univ. of Buffalo, 2183 Main Street, Buffalo 14, N.Y.)

14. Significance of Nucleic Acid Derivatives in Nutrition, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

14–15. Transistor Circuits, conf., Philadelphia, Pa., (G. H. Royer, Westinghouse Electric Corp., 356 Collins Ave., Pittsburgh 6, Pa.)

15–16. National Soc. of Professional Engineers, Charleston, S.C. (P. H. Robbins, 2029 K St., NW, Washington 6.)

15–17. National Assoc. for Research in Science Teaching, annual, Atlantic City, N.J. (C. M. Pruitt, Univ. of Tampa, Tampa, Fla.)

18–20. American Educational Research Assoc., annual, Atlantic City, N.J. (F. W. Hubbard, AERA, 1201 16 St., NW, Washington 6.)

18–22. American Soc. of Civil Engineers, Jackson, Miss. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

18–22. Endocrinology: Hormones in Blood, Ciba Found. Colloq. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Place, London, W.1.)

21–23. National Soc. of College Teachers of Education, annual, Chicago, Ill. (C. A. Eggertsen, School of Education, Univ. of Michigan, Ann Arbor.)

23. American Mathematical Soc., New Haven, Conn. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

23. Oregon Acad. of Science, annual, Monmouth. (F. A. Gilfillan, Oregon State College, Corvallis.)

24–28. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New Orleans, La. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

(See issue of 21 December for comprehensive list)

Advertising office: 11 West 42nd Street, New York 36, N. Y. Pennsylvania 6-1858

SCIENCE | The weekly magazine of research

December 28, 1956

TO RESEARCH DIRECTORS AND COMPANY EXECUTIVES

The Monsanto Chemical Company color spread which appears in this issue represents a bold new trend in industrial advertising. Monsanto Chemical Company, long a leader in developing new ideas, has ushered in a whole new concept in the advertising field in this advertisement. It is their hope that by presenting pertinent facts about their new chemicals to Science readers, they will stimulate the development of new applications for their products. At the same time, they are performing a service to research men in all fields by providing them with information about new materials.

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EQUIPMENT NEWS

All inquiries concerning items listed here should be addressed to Science, *Room 604, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ POLARIZING SPECTROMETER, the Quantum ellipsometer, can be used to measure directly the thickness of films that can be deposited on suitable substrates in thicknesses in the range between molecular dimensions and many hundred angstroms. Both visual and photometric readings are presented. (Quantum, Inc., Dept. S106)

■ GLYCERINE is the title of a booklet that defines terms, describes tests, and presents technical data on various grades of glycerine. The booklet includes detailed specifications covering classification, physical and chemical requirements, test procedures, packaging, storage, and use. (Glycerine Producers' Association, Dept. S109)

■ X-RAY MICROSCOPE consists of an electron gun, accelerating anode, condenser lens, objective lens, aperture, target, and associated equipment for shadow-projection microscopy. The electron beam is focused on the target, a thin beryllium window that is ordinarily coated with tungsten, where the electrons produce an x-ray source less than 1 μ in diameter. The remainder of the instrument is a shadow-projection microscope. Magnification up to 1500 diameters is attainable. (General Electric Co., Dept. S110)

■ SOUND-LEVEL METER AND ANALYZER, the Soundscope, combines the functions of a sound-level meter, an octave-band analyzer, and a narrow-band analyzer. The sound-level meter, in combination with an over-all attenuator, has a range from 24 to 150 db. The analyzer section consists of an octave-band filter set for measuring sound levels in each of the seven octaves from 75 to 9600 cy/sec. A multiplier-dial arrangement that actuates continuously variable high- and low-bandpass filters permits analysis of noise within any octave band to determine noise peaks. (Mine Safety Appliances Co., Dept. S111)

■ HIGH-VACUUM PUMPS are described in a new catalog, "Stokes Microvac pumps for high vacuum." In addition to the specifications for the pumps, catalog No. 752 includes formulas, constants, and conversion factors used in vacuum processing; solutions to problems of pump selection; and information on maintenance procedures for high-vacuum pumps. (F. J. Stokes Corp., Dept. S114)

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GRANTS

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It aids in the determination of: chemical kinetics — electron exchange rates — molecular structures — microscopic electrostatic fields at transition element ion sites — characteristics of conduction band and trapped electrons in metals and semiconductors — and free radical constituents and kinetics in biochemical reactions.

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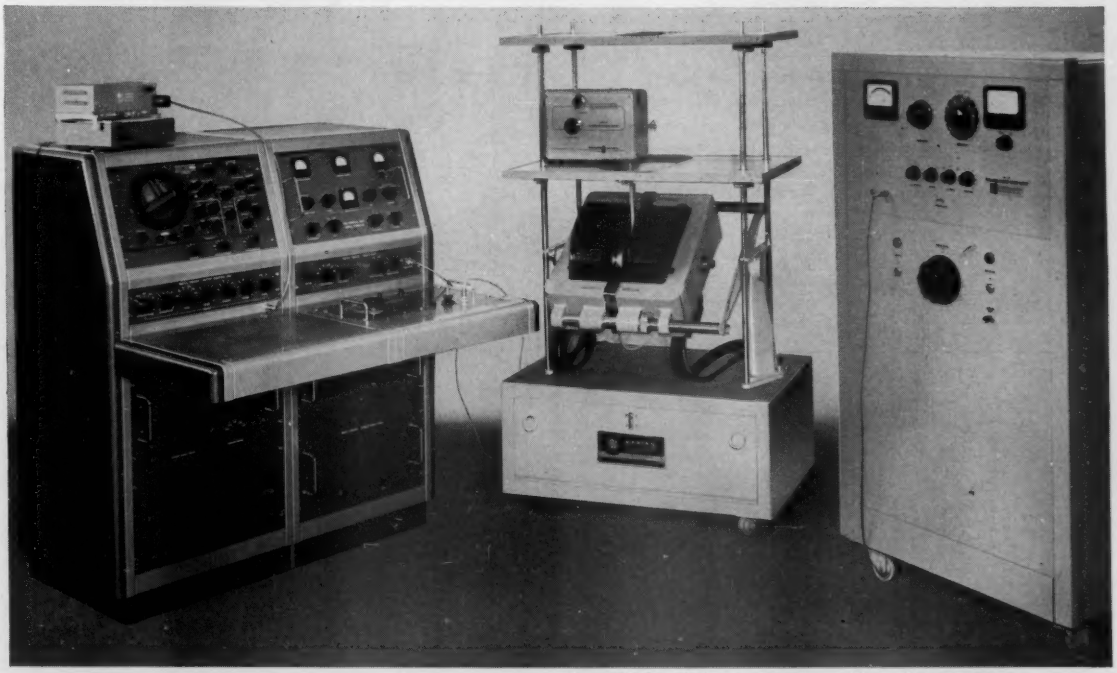

Varian V-4500 E-P-R Spectrometer shown with 6-inch magnet system.

BASIC CHARACTERISTICS OF THE V-4500

OPERATING FREQUENCY:
X-band (nominally 9.5 kmc).

FREQUENCY STABILITY:
Locked to sample cavity to better than one part in one million.

EXTRAPOLATED SENSITIVITY:
$5 \times 10^{-12} \times \Delta H$ moles of electron spins (ΔH is the full width of the absorption line in gauss at half maximum).

COMPATIBILITY:
Compatible with the detection and display components of the Varian Wide Line N-M-R Spectrometer (12-inch magnet system recommended).

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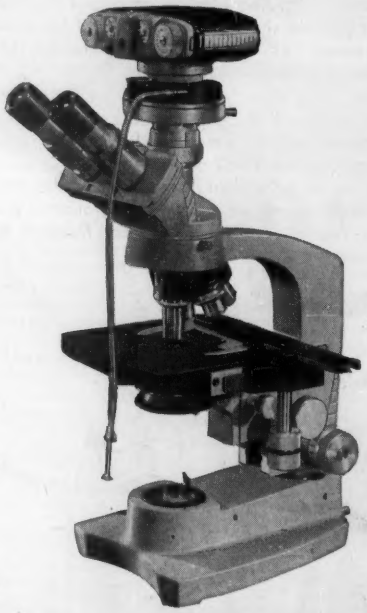

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